LIBRARY

Aeronautical Engineering REVIEW

INSTITUTE OF THE AERONAUTICAL SCIENCES

AIRCRAFT • MISSILES • ROCKETS • SATELLITES • SPACECRAFT

research • design • construction • testing • operation

Future Space Flight Systems

February, 1958

XUM

NO PLACE TO HIDE

They can run but they can't hide from this ARMA Defensive System — the guardian of the B-52.

Called the MD-9, this weapon is just one of ARMA'S "sixth sense" systems . . . systems whose "sensing" abilities derive from the integrated use of gyroscopics, radar, optics, computing, pneumatics and hydraulics.

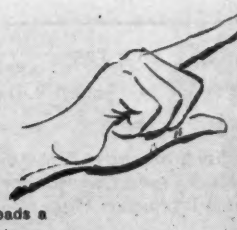
And these "sixth sense" projects provide exciting new areas for engineers. ARMA . . . Garden City, N. Y.

AMERICAN BOSCH ARMA CORPORATION

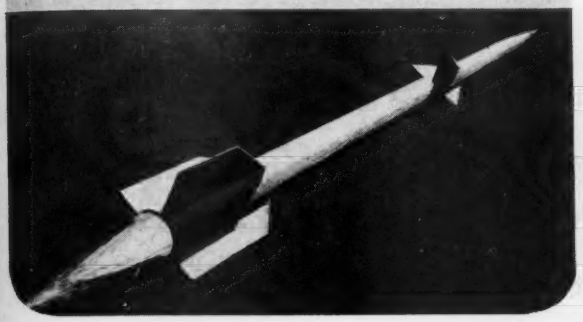
XUM

SOLVING CHALLENGES IN SUPERSONICS:

TO GUIDE:

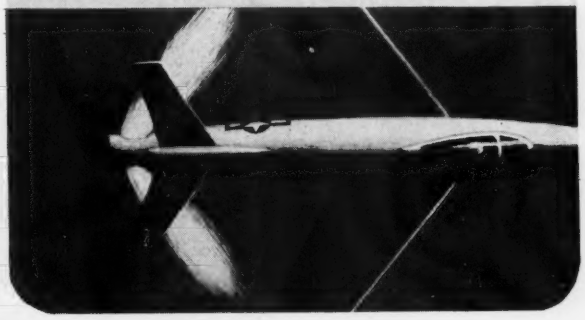


UNERRING GUIDANCE heads a list of electronic achievements engineered by Goodyear Aircraft.

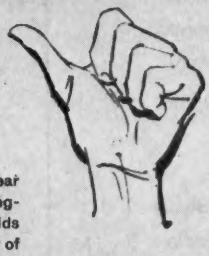


TO HALT:

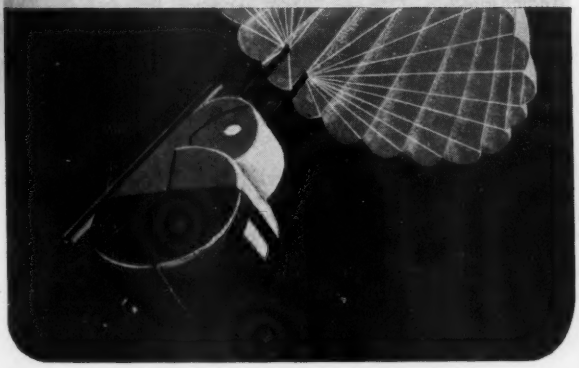
THRUST REVERSAL designed by Goodyear Aircraft makes shortfield capabilities a reality for high-speed jets — promising new margins of safety for carrier-based jet planes.



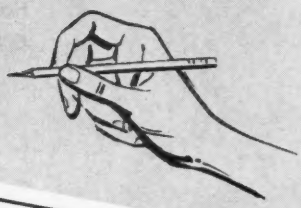
TO ESCAPE:



ESCAPE CAPSULE by Goodyear Aircraft—a down-to-earth, bring-'em-back-alive package — heralds fail-safe escape for any member of a jet crew.



TO FIND OUT:



WRITE TODAY for these and other answers to the challenges of supersonics engineered by Goodyear Aircraft.

GOODYEAR AIRCRAFT

Plants in Akron, Ohio, and Litchfield Park, Arizona. Rewarding Careers for Engineers

XUM

PUBLICATION STAFF

Editor: Welman A. Shrader
Managing Editor: Rita J. Turino
Assistant Editor: Allan Bernhardt
News Editor: Louis F. Slee
Reviews Editor: Irene W. Bogolubsky
Book Reviews Editor: John J. Glennon
Editorial Assistants: Helen S. Goldman
Nancy G. Worssam

TECHNICAL ADVISERS

W. R. Sears • Robert R. Dexter • S. Paul Johnston

BUSINESS STAFF

Advertising Manager: Joseph P. Ryan
Business & Production Manager: Hugh C. Judge
Assistant Production Mgr.: D. C. Lombardi

EDITORIAL ADVISORY COMMITTEES

Aircraft Design, Structures, & Materials

A. Francis Arcier
Wellwood E. Beall
William B. Bergen
Fred N. Dickerman
Robert L. Hall
Edward H. Heinemann
Harold D. Hoekstra
C. L. Johnson
Alexander Kartveli
Kendall Perkins
Richard L. Schleicher
Edgar Schmued
Igor I. Sikorsky
Ernest G. Stout
Kirby F. Thornton
Walter Tydon

Flight Propulsion

George W. Brady
Dimitrius Gerdan
Leonard S. Hobbs
R. P. Kroon
Everard M. Lester
W. G. Lundquist
Abe Silverstein
Philip B. Taylor
E. S. Thompson
Raymond W. Young

Instruments

Preston R. Bassett
Victor E. Carbonara
Charles H. Colvin
Frank R. Cook
Richard M. Mock
Walter H. Skidmore
R. C. Sylvander

Air Transport & Operations

Charles Froesch
J. A. Herlihy
John C. Leslie
William Littlewood
R. W. Rummel
R. Dixon Speas

Electronics

K. C. Black
Bruce G. Eaton, Jr.
Richard B. Hubbard
David S. Little
Frank Mansur
John Margosian
P. C. Sandretto

Specialties

Robert J. Benford, M.D.
Melvin N. Gough
Jerome Lederer

SUBSCRIPTION RATES

Aeronautical Engineering Review: United States and possessions, 1 year, $5.00; single copies, $0.50. Foreign countries including Canada (American Currency Rates), 1 year, $6.00; single copies, $0.50.

Second-Class Mail Privileges Authorized at Easton, Penna. Acceptance for mailing at a Special Rate of Postage as provided for in the Act of August 24, 1912.

Publication Office: 20th & Northampton Streets, Easton, Pa.

Editorial Office: 2 East 64th Street, New York 21, N.Y. Notices of change of address should be sent to the Institute at least 30 days prior to actual change of address.

Statements and opinions expressed in the Aeronautical Engineering Review are to be understood as individual expressions and not those of the Institute.

© *Copyright, 1958, by the Institute of the Aeronautical Sciences, Inc.*

Aeronautical Engineering Review

Vol. 17—No. 2 February, 1958

CONTENTS

Business Implications of Future Space Flight Systems.....*William H. Dorrance* 20

Flow Visualization.....*A. M. Lippisch* 24

Autorotation of Fuselages.....*Mark H. Clarkson* 33

Aircraft Overrun Barriers.....*Major John E. Snow, USAF* 37

The Weapons System Approach to Air Data Computing.....*H. F. Creel* 41

Research and Development Planning in the USAF.....*Lt. Col. Carlo R. Tosti* 45

Estimating Structural Box Weight.....*Lyle D. Green and Joseph Mudar* 48

IAS News Notes..... 9

IAS News..... 13

Dateline World..... 17

Editorial.....18, 19

Aeronautical Reviews..... 71

International Aeronautical Abstracts..... 75

Books..... 115

Personnel Opportunities..... 119

IAS Preprints..... 120

Index to Advertisers..... 121

New Products and Product Literature..... 123

Cover—The Fairey Rotodyne, a 48-passenger VTOL airliner, flew for the first time in early November, according to Fairey Aviation Company Ltd., Great Britain. A 90-ft. diameter four-blade rotor lifted the aircraft from the ground before two Napier Eland propeller-turbines drove it forward at a reported speed of 200 m.p.h. For take-off, compressed air is piped from the Eland engines through the blades where it is burned with fuel in tip jet units. The aircraft weighs 17 tons and will carry $4^1/_2$ tons of freight (besides passengers) for a range of 400 miles at a cruising speed of 185 m.p.h.

Published Monthly by the

Institute of the Aeronautical Sciences, Inc.

2 East 64th Street, New York 21, N.Y.

TEmpleton 8-3800

Western Office: 7660 Beverly Blvd., Los Angeles 36, Calif.

When does Sound Become Noise?

Photo Courtesy Lockheed Aircraft Corporation

Unless you can calibrate your ear, the only positive way to answer this question is by accurate measurement with instruments. Subjective results are often misleading and provide only partial answers. For accurate and complete results, industries specify General Radio sound-measuring equipment. This fully-integrated line features instruments for sound-level measurements of either high-, medium-, or low-level sounds; sound analyzers for either narrow- or wide-band analysis; impact-noise analyzers; vibration meters and analyzers; and a complete line of accessories to further extend system versatility. Write for "The Sound Bulletin" and get the complete story on sound measurement.

Evaluating Noise by Octave-Band Methods preliminary to soundproofing a hydraulic-pressure generating system at Lockheed's test laboratory. The spectral distribution of noise determined with the G-R Octave-Band Analyzer defines the problem and aids in the prescription of proper soundproofing treatment (Sound-Level Meter serves as preamplifier for Analyzer).

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass., U.S.A.

Broad Avenue at Linden, Ridgefield, N. J. **NEW YORK AREA** 1000 N. Seward St. **LOS ANGELES 38**

8055 13th St. Silver Spring, Md. **WASHINGTON, D. C.** 1150 York Road, Abington, Pa. **PHILADELPHIA**

1182 Los Altos Ave., Los Altos, Calif. **SAN FRANCISCO** 6605 W. North Ave., Oak Park, Ill. **CHICAGO**

In **CANADA**: 99 Floral Parkway, **TORONTO 15**

All G-R Products are now covered by a *2-Year Warranty*

IAS News Notes

February 1958

LAST CALL: Candidates for the IAS Flight Test Engineering Fellowship have until March 1 to file applications. Qualifications are a B.S. in Engineering (no later than June, 1958) and U.S. citizenship. Forms are available by a request in writing, endorsed by a sponsor, to Flight Test, Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, New York.

NEW IAS CORPORATE MEMBER is Bulova Research and Development Laboratories, Inc., with headquarters at 62-10 Woodside Avenue, Woodside 77, New York.

THE NAVY'S ANSWER to the shortage of scientific personnel, a Scientific Education Plan for selected enlisted men, is explained in detail on page 15.

NACA CHAIRMAN James H. Doolittle, past president of the IAS, has named H. Guyford Stever, 1958 IAS Vice President, to head a new Space Technology Committee for the NACA.

NATIONAL MEETINGS CALENDAR

Mar. 13-14	Flight Propulsion Meeting (Classified) Hotel Carter, Cleveland.
Mar. 17-21	1958 Nuclear Congress, International Amphitheatre, Chicago. IAS participating.
Apr. 28-30	Second Annual AFOSR Astronautics Symposium, Shirley-Savoy Hotel, Denver, Col. Sponsored by IAS.
May 12-14	National Conference on Aeronautical Electronics, Dayton, Ohio. IRE-IAS participating.
May 12-14	Midwestern Conference on Guided Missiles, Hotel Chase, St. Louis.
June 2-4	National Telemetering Conference, Lord Baltimore Hotel, Baltimore, Md. Sponsored by IAS, ARS, ISA, and AIEE.
June 19-20	1958 Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley. Cosponsored by IAS.
July 8-11	National Summer Meeting, Ambassador Hotel, Los Angeles.
Sept. 8-13	First International Congress, International Council of the Aeronautical Sciences, Palace Hotel, Madrid, Spain.
Oct. 7-8	Canadian Aeronautical Institute-IAS 1958 Joint Meeting, Chateau Laurier, Ottawa, Canada.
Dec. 17	Wright Brothers Lecture, Washington, D. C.
1959	
Jan. 26-29	Twenty-Seventh Annual Meeting, Sheraton-Astor Hotel, New York.

SECTION MEETINGS CALENDAR

Feb. 4	Hampton Roads Section: General Meeting, NACA East Projection Room, Langley Field, Va., 8 p.m. "SeaMistress" by G. Mallery.
Feb. 4	San Diego Section: General Meeting, IAS Building, 8 p.m. "Air Traffic Control" by F. Yore.
Feb. 5	Philadelphia Section: Dinner Meeting, Skyview Dining Room, International Airport. (Social period at 6:30, dinner at 7.) "Some Factors in the Jet Transport Picture" by N. R. Parmet.
Feb. 5	Rocky Mountain Section: Dinner Meeting, Boulder Country Club. (Social period at 6, dinner at 7 p.m.) Discussion - activities at Beech Aircraft. Tour - Natl. Bureau of Standards Boulder Labs.
Feb. 5	Chicago Section: Dinner Meeting, Austin Fine Arts Club, 6:30 p.m. "Safety Aspects of Jet Engines and Development of the J-79 Engine" speaker to be announced.
Feb. 6	Baltimore Section: Dinner Meeting, Applied Physics Lab, Howard County, Md., 7 p.m. CLASSIFIED. "ICBM" by Major General Bernard A. Schriever, USAF.
Feb. 11	Los Angeles Section: Specialist Meeting, IAS Building, 7:30 p.m. "Simplified Performance Analysis for High-Speed Propulsive Devices" by Charles A. Lindley.
Feb. 11	Washington Section: Dinner Meeting, Occidental Restaurant. (Social period at 6, dinner at 6:45 p.m.) "Rocket Prolusion Requirements for Satellite and Moon Missions" by John L. Sloop.
Feb. 12	Seattle Section: Dinner Meeting, place to be announced. (Social period at 6, dinner at 7 p.m.) "Defense Plans" by H. F. Hansell.
Feb. 13	Atlanta Section: General Meeting, Helenic Center, Atlanta, time to be announced. "A Study of Engine Characteristics Best Suited for Commercial Operations" by Franklin W. Kolk.
Feb. 18	San Diego Section: General Meeting, IAS Building, 8 p.m. "Field Trip and Talk, Convair Ramp" by R. P. White.
Feb. 18	Cleveland-Akron Section: Dinner Meeting, Thompson Products Auto Album, E. 30th and Chester Ave., Cleveland. (Social period at 6, dinner at 7 p.m.) Discussion - "Manned High-Altitude Balloon Flights" by John Winzon.
Feb. 20	Los Angeles Section: Dinner Meeting, IAS Building. (Social period at 6, dinner at 7 p.m.) "IGY With Rockets and Satellites" by Joseph Kaplan.
Feb. 25	Kansas City Section: Dinner Meeting, place to be announced. (Social at 5:30, dinner at 6:30 p.m.) "USAF Academy Scientific and Engineering Program" by Lt. Col. G. C. Clementson.
Feb. 25	Los Angeles Section: Specialist Meeting, IAS Building, 7:30 p.m. "Minimum Weight Design of Sandwich Panels" by L. E. Kaechele.
Mar. 10	Boston Section: General Meeting, M.I.T. Kresge Auditorium, 8 p.m. The Minta Martin Lecture by H. W. Emmons.
Mar. 13	Baltimore Section: Dinner Meeting, Applied Physics Lab., Howard County, Md., 7 p.m. CLASSIFIED. "The Future of Missiles" by Simon Ramo.

IAS News

A Record of People and Events of Interest to Institute Members

Thirteenth Flight Propulsion Meeting Schedules Four Classified Sessions

Papers on Rocket, Nuclear, Air Breathing Engines

Planned for 2-Day Program at Hotel Carter, Cleveland

A TENTATIVE PROGRAM for the Thirteenth Annual Flight Propulsion Meeting calls for 14 technical papers to be presented on March 13 and 14 at the Hotel Carter, Cleveland, Ohio. (The meeting is classified.)

The 2-day program will be divided into four sessions covering air breathing engines, nuclear engine technology, rocket technology, and rocket systems. A banquet and an address by a prominent figure in aviation (to be announced later) also are on the meeting agenda.

Technical Papers

A general subject list of the 14 papers scheduled includes:

Air breathing engines: Buzz-yaw coupling problems, the dual-cycle propulsion system, SF-1 propulsion systems for flight at high altitudes, and high Mach ram-jets.

Nuclear engine technology: In-file loop testing, techniques in aircraft radiation shielding, and large-scale hot lab techniques.

Rocket technology: Operational problems with solid propellants, high energy liquid rockets (two papers), and LOX-RP engine development problems.

Rocket systems: Army operational experience, USAF operational experience, and propulsion systems for space flight.

Meeting Planners

D. D. Wyatt, Associate Chief, Propulsion Aerodynamics Division, NACA Lewis Flight Propulsion Laboratory, is Program Chairman for the meeting. Assisting with the program is W. T. Olson, also of NACA. Wilson Hunter (NACA) is in charge of physical arrangements, and Bruce H. Nulthaup, Thompson Products, is in charge of displays.

D. D. Wyatt
Program Chairman

Technical support will be supplied by the ARDC, and the gigantic task of processing more than 1,000 expected security clearance applications will be handled by that Air Force agency.

Publication of Papers

As was the case last year, the classified papers presented at the meeting will be considered for publication by the Armed Forces Technical Information Agency for distribution to established users of AFTIA services. Though the meeting still is in the formative stages, unclassified papers that may possibly be presented will be published by the IAS through the Sherman M. Fairchild Fund at some later date. If such papers are presented, their availability will be announced in the AERONAUTICAL ENGINEERING REVIEW.

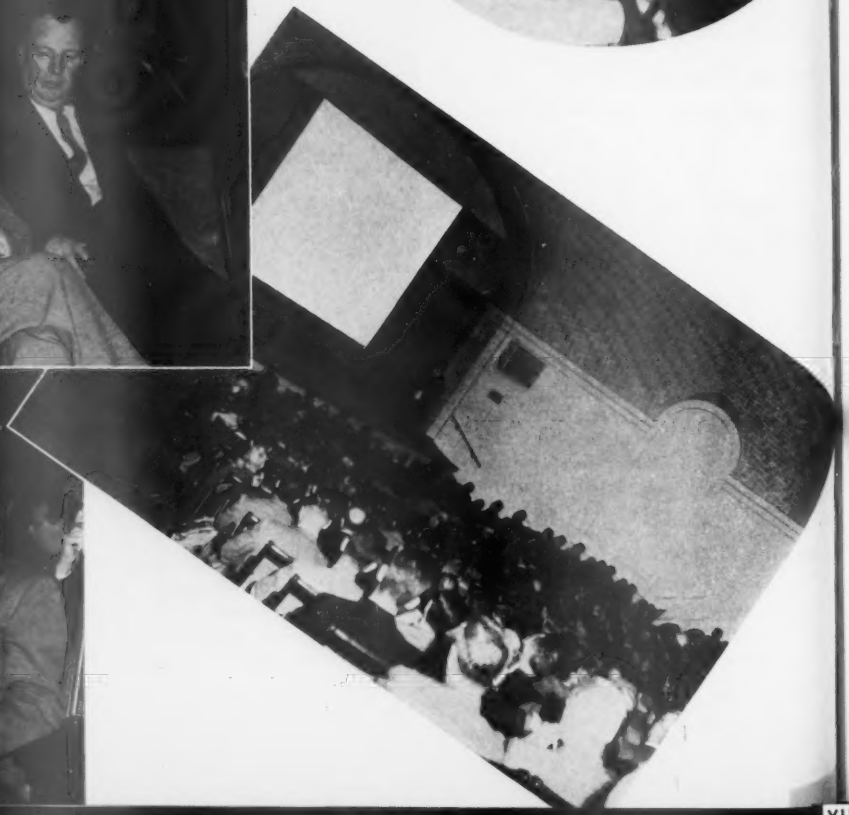
Local aircraft industries in the Cleveland area again this year will lend their support to the meeting with interesting exhibits.

Companies that participated in last year's meeting included Aircraft Components Division of Ferrotherm, American Steel and Wire; Cleveland Pneumatic Tool; General Tire & Rubber; B. F. Goodrich; Goodyear Aircraft; Jack & Heintz; Pesco Products; Romec Division of Lear; Steel Improvement & Forge; and Thompson Products.

The classified nature of these annual Flight Propulsion Meetings precludes any detailed reporting. However, it is no violation of security to state that this year's program, arranged and handled by officers and members of the IAS Cleveland-Akron Section and assisted by Past President E. R. Sharp's NACA staff, is shaping up as the best yet.

The IAS at Montreal and Washington

These random shots from the CAI-IAS joint meeting in Montreal, in October (*top three*) and those taken at the Wright Brothers Lecture in Washington, December 17 (*bottom three*) are an indication of the continuing interest in Institute meetings and activities—wherever and whenever held.



McCarthy, Russell Given Collier Trophy

Vice-Adm. James S. Russell and Charles J. McCarthy, Fellows of the Institute, have been chosen joint recipients of the Collier Trophy Award for 1956 for conception, design, and development of the F8U Crusader.

Mr. McCarthy, a past president of the IAS, is Chairman of the Board, Chance Vought Aircraft, Incorporated. Admiral Russell is Chief, Deputy Commander-in-Chief, Atlantic Fleet.

The trophy is given annually for "the greatest achievement in aviation in America, the value of which has been demonstrated by actual use during the preceding year." It is awarded by the National Aeronautic Association.

IBM Division Joins Corporate Members

Newest Corporate Member of the Institute is the International Business Machines' Corporation Military Products Division, with research, engineering, and manufacturing facilities in Kingston and Owego, N.Y.

The Kingston plant has been associated with development and manufacture of Sage System air warning equipment. The same engineers and mathematicians who worked on the Sage System now form an Air Traffic Control Project.

The Owego plant produces bombing, radar, and navigation equipment for the USAF B-52. Designated AN/ASB-4, this equipment electronically calculates and compensates for speed, altitude, drift, rotation of the earth, and bomb ballistics to guide the B-52 automatically to a predetermined bomb-release point, drop the bomb, and guide the aircraft back home.

Scientist Shortage?

Battle Stations for Higher Education Is Navy's Answer

Of more than passing interest to IAS members is the Navy's new scientific education plan, announced in December, which has been hailed as a big step toward increasing scientific manpower in the United States.

Beginning with the school year 1958–1959, the program will educate 500 selected enlisted men. Some eventually will become part of the naval officer corps; some, part of the Navy's reserve units. All will contribute to the scientific potential of the country.

Enlisted men will be enrolled in civilian colleges and universities for courses leading to B.S. degrees and Navy commissions. They will be required to remain on active duty as officers for a period equal to time enrolled in the program.

A selection board of naval officers and civilians experienced in education will pass upon applicants on the basis of intelligence and aptitude. Enrollees will receive the pay and allowances of their rates while students. Educational costs will be paid by the Navy Department.

Study emphasis will be on mathematics and the physical sciences. During summer vacations, students will be assigned to naval and outside laboratories to study application of the sciences.

The program was inspired by Adm. Luis de Florez, USNR (Ret.), IAS Fellow and Founder Member. It has received the enthusiastic support of the Secretary of the Navy and the Bureau of Personnel.

Library Reduces Photoprint Price

The Institute's National Headquarters Library has reduced the price of photocopy prints—*not* of articles photocopied, as incorrectly printed in the December IAS News Notes. The price to members has been reduced from $0.40 to $0.30 per print, and to nonmembers from $0.50 to $0.40 per print, including mailing. (Usually one print is made per page.) IAS scrip coupons may be used for payment.

NEWS OF MEMBERS

▶ **W. H. Arata, Jr.** (AF), has been given new responsibilities at Fairchild Aircraft Division, Fairchild Engine and Airplane Corporation, incorporated in the title Chief Project Engineer—Aircraft. His previous assignment was Chief Operations Engineer.

▶ **R. L. Bisplinghoff** (F), Professor of Aeronautical Engineering, Massachusetts Institute of Technology, has been appointed Deputy Head, Department of Aeronautical Engineering, M.I.T.

▶ **Krafft A. Ehricke** (M), Convair Astronautics, has won the American Rocket Society's Astronautics Award for "outstanding contribution to the advancement of space flight."

▶ **Major Gen. Donald J. Kiern** (AF) has been named by the Defense Department to head a new office to direct development of nuclear power for airplanes and missiles.

▶ **Edwin A. Link** (AF), Chairman of the Board, Link Aviation, Inc., and inventor of the flight simulator, has been selected by the National Aeronautic Association to receive the 1957 Frank G. Brewer Trophy for the advancement of aviation education

▶ **Captain Grayson Merrill, USN (Ret.)** (AF), Fairchild Guided Missiles Division, has been named winner of the G. Edward Pendray Award by the American Rocket Society for "outstanding contribution to the rocket and jet propulsion literature."

Members on the move . . . .

This section provides information concerning the latest affiliations of IAS members. All members are urged to notify the News Editor of changes as soon as they occur.

Thomas R. Carroll (AF), formerly Assistant Design Manager, has been appointed Deputy Design Manager (Britannia), Bristol Aircraft Limited, Bristol, U.K.

John C. Ford (M) has joined Temco Aircraft Corporation as Assistant Project Engineer. He formerly was an Assistant Project Engineer at Chance Vought Aircraft, Inc.

Theodore A. Fore (A), formerly Production Methods Engineer, Lockheed Aircraft Corporation, California Division, has been transferred to Lockheed Missile Systems Division at Van Nuys as Manufacturing Engineer.

Commander Robert F. Freitag (AF) has been transferred by the Navy to the Naval Air Missile Test Center, Point Mugu, Calif., and assigned as Pacific Missile Range Officer on the Staff of the Center Commander. His previous assignment was Project Officer, Polaris and Vanguard rockets, Office of the Chief of Naval Operations, Washington, D.C.

Charles L. Gage (M), formerly an Engineering Supervisor, Commercial Division, Weber Aircraft Corporation, has joined Modglin Company, Inc., as Chief Project Engineer.

Wayland C. Griffith (M), formerly Physics Professor at Princeton University, is now Flight Sciences Division Manager, Lockheed Aircraft Corporation Missile Systems Division, Palo Alto, Calif.

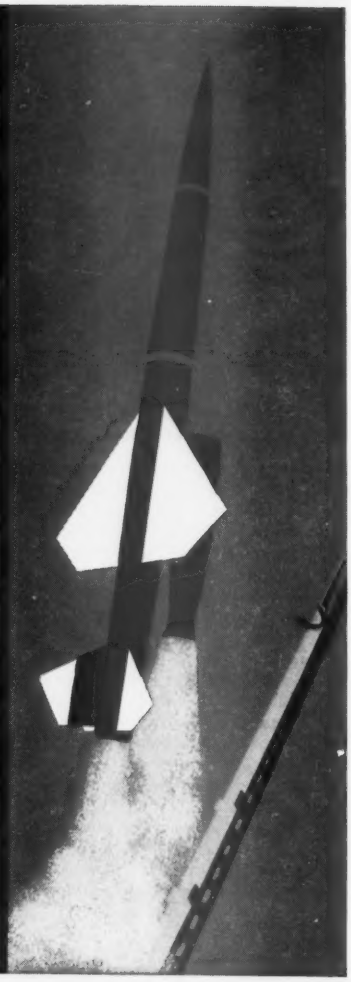
Boone Guyton (M), formerly Manager, Sales, Norden-Ketay Corporation's Instruments and Systems Division, has joined Hamilton Standard, Division of United Aircraft Corporation, as Sales Manager, Electronics Department.

R. L. Halfman (M), Associate Professor, Aeronautical Engineering, Massachusetts Institute of Technology, has been appointed Executive Officer, Department of Aeronautical Engineering, M.I.T.

(*Continued on page 52*)

XUM

T	E	L	E	M	E	T	E	R	I	N	G
		A							N		
	F	U	E	L	I	N	G		S		E
		N							T		N
		C			R	A	D	A	R		G
		H							U		I
		I			P				M		N
C	O	N	T	R	O	L			E		E
H		G			W		S		N		E
E					E		U		T		R
C					R		P		A		I
K							P		T		N
O					S	T	O	R	I	N	G
U							R		O		
T				T	E	S	T	I	N	G	



Looking for solutions?

AMF has missile experience you can use

• Building a reliable missile system introduces problems at every step . . . the kind AMF solves daily. From drawing board to target, AMF is constantly bridging the gap between missile concept and performance. • This wealth of experience, gained as a leading contributor to numerous major missile programs, can produce the solution to your particular problem. • For a full description of AMF engineering and production facilities in the missile field, as well as a review of their performance, contact the AMF Defense Products Manager in any of the cities listed below.

- *Armament*
- *Ballistics*
- *Radar Antennas*
- *Guided Missile Support Equipment*
- *Auxiliary Power Supplies*
- *Control Systems*

AMF DEFENSE PRODUCTS

Defense Products Group
AMERICAN MACHINE & FOUNDRY COMPANY
1101 North Royal Street, Alexandria, Va.

Asbury Park • Atlanta • Boston • Brooklyn • Dallas • Dayton • Los Angeles • Seattle • Tucson • Washington, D. C.

DATELINE World

PROFESSIONAL NOTES AND REPORTS

Engineering and Scientific Briefs from Correspondents Around the Globe

Soviet Aerodynamics Textbook, Published in 1957, Is Reviewed

◆ A new textbook *Aerodynamics of the Airplane*, by I. V. Ostoslavski, published by State Publishing House of the Defense Ministry (1957), has recently been reviewed. This massive text (560 pp.) is an official standard text for use in all Soviet aeronautical engineering institutes. It consolidates and combines the contents of two previous books in which the same author collaborated (*Aerodynamic Calculation of the Airplane* by I. V. Ostoslavski and V. M. Titov, 1947, and *Longitudinal Stability and Controllability of the Airplane* by I. V. Ostoslavski and G. S. Kalachev, 1951) and is presumably used in a fourth or fifth year course of Applied Aerodynamics. The book, and presumably the course, is clearly divided into two parts: Aircraft Performance (pp. 19–212) and Aircraft Stability and Control (pp. 213–556). A full-year course consisting of essentially these two halves is standard in the senior or first graduate year of any aeronautical engineering department in this country or abroad.

Chapter 1, of Part I, Performance, begins with an introduction which lists the forces acting on an aircraft in a vertical plane through its center of gravity (lift, drag, thrust, gravity) and defines some equations of motion and the properties of the standard atmosphere.

Chapter 2 briefly indicates how the aerodynamic coefficients (lift, drag, pitching moment, propeller performance, etc.) vary with incidence, Mach Number, and Reynolds Number. There is no real analysis, though there is a discussion of transonic drag rise and of tip stall on swept wings on a rather elementary level.

This information is then used to develop two methods of performance calculations. One of these, attributed to N. E. Joukowski, consists in solving the equations of motion point by point along a trajectory (Chapter 3), and the other, which is standard in the United States, consists in comparing power available and power required under various altitude and velocity conditions (Chapter 4).

Chapter 5 discusses the range and endurance of propeller-driven and turbojet aircraft along conventional lines; numerical examples for a subsonic (500 m.p.h. cruise) bomber of 4,000-mile range are worked out, and the effect of in-flight refueling is briefly discussed.

Chapters 6 and 7 present an elementary discussion of the kinematics and dynamics of maneuvers, first in the vertical plane (climb, glide, dive, loop, etc.) and then in space (banked turn, skid, military maneuvers, etc.), determining the loss in performance due to the g's pulled, the time needed to perform the maneuvers, and related problems.

The last chapter of Part I (Chapter 8) deals in a conventional manner with the mechanics of take-off and landing, operational design requirements, assist devices, and other similar factors.

Part II of the book deals with static and dynamic stability and control. It is a revised version of the 1951 book *Longitudinal Stability and Controllability of the Airplane*.

In Chapter 1, the equations of motion for an aircraft slightly disturbed from equilibrium are derived, and relations for the characteristic frequencies are worked out.

Chapter 2 treats the problem of longitudinal air loads, taking some pains to explain the effects of compressibility (subsonic up to transonic) and of wing sweep on the shape of the moment curve. This chapter gives a more sophisticated aerodynamic picture than Chapter 2 of Part I. Trimming and control-surface deflection are discussed briefly.

Chapter 3 considers loads developed in roll and yaw, with particular emphasis on the effects of sweep, dihedral, fuselage and tail interference, and unbalanced engine operation.

Chapter 4 consolidates and coordinates this information and defines all the required aerodynamic response and damping coefficients important in curved flight.

Chapter 5 deals with control surface effectiveness in terms of a given angular displacement of the surface and in terms of a given load applied by the pilot to the control. Boost systems (springs and servomechanisms) are considered.

After this lengthy development of background, Chapters 6 and 7 discuss longitudinal stability to small oscillations, and Chapters 8 and 9 deal with the lateral stability. The analysis appears conventional. Longitudinal and lateral modes are separated. The long- (phugoid) and short-period oscillations are discussed in detail. A simple autopilot is sketched; response to maneuvers is shown on oscillograph records and computed. The greater efforts on the pilot at high speeds are illustrated. A similar analysis is then carried out for transverse oscillations.

Chapter 10 discusses stalled flight and spin and Chapter 11 stability on the ground during taxiing. Finally, Chapter 12 introduces aeroelastic effects on stability and control.

Where subject matter overlaps, the new text is no significant departure from the 1951 book mentioned. It is a good treatment of classical stability and control material but does not deal with the more modern nonlinear response and cross-coupling problems.

U.S.S.R.'s Hotel-Airplane May Be Seen Soon by West

◆ The U.S.S.R. continues to ballyhoo the Tu-114, a Tupolev-designed transport named the "Rossiya" (meaning Russia) frequently lauded during the past year but never shown.

Early in 1957 Soviet press releases referred to the Rossiya as the "white hope" of the U.S.S.R. for nonstop service between Moscow and New York and hinted that the world would not have long to wait to see the hope realized. Year's end found the plane's press agents still flying high, while, so far as the Western World knew, the Rossiya herself had not flown at all. The transport was by this time described as "the largest passenger aircraft in the world," equipped with two passenger elevators, a telephone system, and a restaurant for 48 people. The passenger capacity for the 10- to 12-hour, Moscow/New York nonstop flight was now given as 120. It was added that on flights of from 400 to 500 nautical miles, the Rossiya could carry 220 passengers and would accommodate 170 passengers on intermediate stages of unspecified length. A flight crew of ten operates the very large transport, it was said.

The latest word from the Russians, as this issue goes to press, is that the West will see the Rossiya *soon*.

XUM

IAS PRESIDENTS

1958

We Welcome . . .

. . . as 26th President of the Institute, Edward C. Wells, IAS Fellow, and Vice-President—Engineering and member of the Board of Directors, Boeing Airplane Company. Mr. Wells, 1942 Sperry Award winner, will place at disposal of the Institute the knowledge and experience gained over a period of 22 years at Boeing as both a distinguished designer of many famous aircraft and an administrator. Under the leadership of one of the most capable executives in the aircraft industry, the Institute can look forward to another year of service, growth, and accomplishment in advancement of the aeronautical sciences.

We Thank . . .

. . . the Institute's Silver Anniversary President, Mundy I. Peale. Despite the exacting demands made upon him as Republic Aviation Corporation President, Mr. Peale has given a great deal of his time and wise counsel to IAS plans and activities. His business acumen has been brought to bear to the benefit of his professional society. Mr. Peale receives our thanks for serving us well at a time when the Industry's flight through the year has been through somewhat "bumpy" air.

1957

EDITORIAL

"SHOW BUSINESS"

It recently came to our attention that an organization known as International Aviation Shows is soliciting aircraft industry participation in a trade show scheduled for September, 1958, in the New York Coliseum.

This would ordinarily cause us little concern, for, as pointed out below, we have no direct interest in such an activity. What does concern us, however, is the widespread and indiscriminate use of the initials IAS in its promotional literature.

The letterhead used for solicitation features the initials "I.A.S." in bold, black, embossed letters set off against a blue swatch, with the full name in quite subdued type, almost as incidental decoration. Throughout the body of the letter, the initials "I.A.S." are freely used. An attached pamphlet also uses "I.A.S." frequently, with incidental mention of the full name.

Any organization may certainly use its own initials in its own literature, but this use of the Institute's traditional designation among aviation people to solicit business from the aircraft industry seems to imply sponsorship or participation on our part. In order to make our own position clear we immediately sent the following telegram to our Corporate Members:

ATTENTION HAS BEEN CALLED TO FREE USE OF INITIALS "I.A.S." IN LITERATURE SOLICITING INDUSTRY PARTICIPATION IN A TRADE SHOW BY ORGANIZATION CALLED "INTERNATIONAL AVIATION SHOWS." THIS IS TO ADVISE THAT THE INSTITUTE AERONAUTICAL SCIENCES HAS NO REPEAT NO CONNECTION WHATEVER WITH THE ABOVE ORGANIZATION.

A policy statement: *The Institute of the Aeronautical Sciences has no plans to participate in or to sponsor any National show or exhibit now or in the foreseeable future.*

Several times in the past few years the Institute's Officers and Council have considered the question of the desirability of equipment exhibits in connection with our national meetings. This is because periodically someone observes that other organizations sponsor shows and suggests that we do likewise. The arguments usually advanced are that (a) exhibits tend to augment attendance at meetings; (b) engineers learn what is new by examining products of their competitors; and (c) show sponsors can make a substantial profit.

Under present conditions there is little doubt that money is to be made from sponsoring shows and exhibits. Any responsible organization with access to an empty hall (or to a large tent) can probably persuade enough customers to come along to produce a net profit. Most equipment suppliers can whip up an exhibit, complete with sales brochures, that can be set up in any hotel lobby or exhibit hall in a very brief space of time. Also one can find plenty of professional exhibition managers eager to be of help. They will run the whole thing—including lights, incidental music, and the unions—for a substantial fee, with a guaranteed profit for the sponsor.

Obviously exhibitors are willing to pay well for such things because they expect to sell somebody something by so doing. There is nothing unusual or reprehensible in this. That is one way we do business in America. But let's face it. Such exhibits are strictly trade shows, nothing more or nothing less, and if they are inherently worth while they should be sponsored by trade associations, not scientific societies.

Look, for example, at the Farnborough Show in England. This is an outstanding example of what a trade show can be. But who puts it on? And for what purpose? The Society of British Aircraft Constructors sponsors it. Its announced objectives are twofold: (1) to sell British merchandise in foreign markets, and (2) to show what British taxpayers get for their money.

As for attracting additional attendance at meetings, we must ask who it is that we are really trying to attract—for whom are IAS meetings designed? Not the public; our discussions are over their heads. Our meeting programs are designed for the maximum benefit of our *members*. The things that seem to us to be most important in attracting the right kind of people to national meetings are timely programs, good papers well presented, and worth-while discussions. People also come to interchange their ideas informally with others of the same professional persuasion.

Whether equipment displays at such meetings add anything to these specifications is questionable. Gadgetry so displayed is *ipso facto* unclassified and very likely outdated. There can be little that is startlingly new to the average well-informed engineer. It is always fun to turn knobs and watch wheels go round, but the actual value to the scientists and engineers that make up our membership is doubtful.

If the IAS mission were to educate the public or to create general interest in Identifiable Flying Objects and their components, this would be quite another matter. Since this is not our primary objective, however, we must expend what energies we have in proper directions. Our purpose must always be to augment the professional capabilities of our members. The "convention" or "trade show" atmosphere is not conducive to this end.

So, we intend to stick to our own knitting. We will present to our membership the best possible programs we can put together. We will generate and will maintain around them the most favorable possible climate for interchange of scientific and engineering information. We will continue to encourage the youth of America along scientific and technical lines and will assist engineering students in our schools in every possible way. If we continue to do a first-class job in these areas, we are certain we can count on adequate support from industry without trade shows or other "gimmicks." We think that we serve our "customers" best by staying out of "show business."

S.P.J.

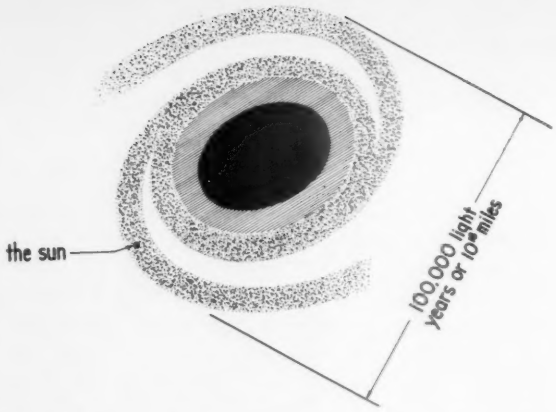


FIG. 1. The Milky Way—our galaxy as it would appear from above its central plane.

Business Implications

INTEREST IN SPACE-FLIGHT SYSTEMS, both manned and unmanned, has increased considerably in recent years primarily because of military support of long-range ballistic missile programs and the increase of interest in earth satellite systems by respected members of the scientific community. The scientific uses of earth satellites have been well recognized and cataloged.[1] Scientists and engineers have dwelt at great length on various space-flight systems ranging from earth satellites to interplanetary, and, in their extreme moments, to interstellar and intergalactic excursions.[2] Since the manufacture, testing, and developing of the vehicles and equipment supporting such systems will logically fall to the air-frame industry and its derivative industries, it seems timely to assess the possible market and business implications involved.

It is the purpose of this paper to attempt to answer the following questions using data and knowledge now at hand.

(1) What systems are technologically feasible?

(2) Who are the potential customers of such systems?

(3) How much business is involved in preparing for space flight? When?

(4) Which direction should research take in order to increase the horizons and reduce the cost of space flight?

Any answers provided herein will necessarily be conservative. As with any large-scale and complex development, the needs and usefulness of various space-flight systems will only become apparent during the course of progress. Commercial, scientific, economic, and military uses and needs for space-flight systems not

Mr. Dorrance is Assistant to the Director of Scientific Research in the Convair General Offices.

This paper was written and submitted prior to Sputnik I.

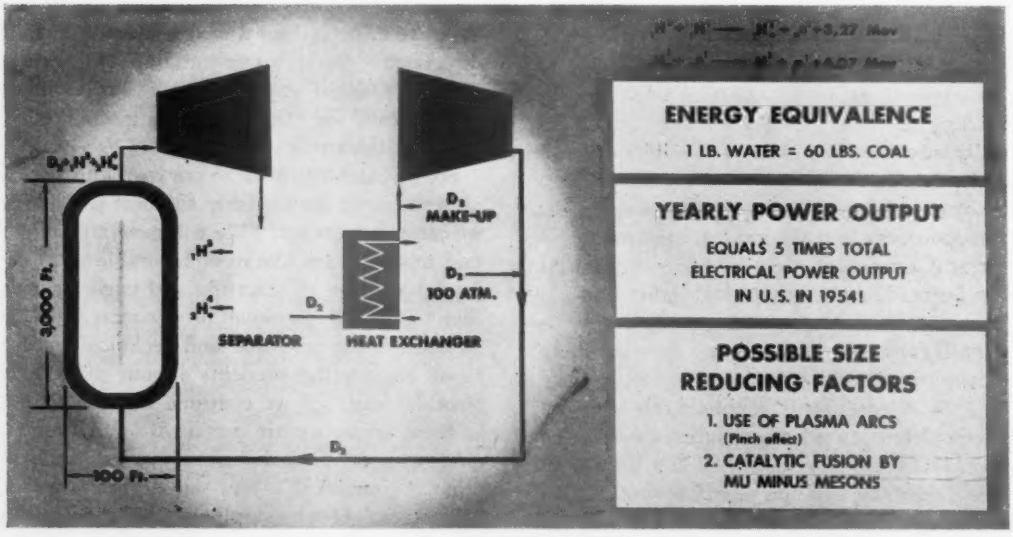

ENERGY EQUIVALENCE
1 LB. WATER = 60 LBS. COAL
YEARLY POWER OUTPUT
EQUALS 5 TIMES TOTAL ELECTRICAL POWER OUTPUT IN U.S. IN 1954!
POSSIBLE SIZE REDUCING FACTORS
1. USE OF PLASMA ARCS (Pinch effect)
2. CATALYTIC FUSION BY MU MINUS MESONS
D₂ MAKE-UP
D₂ 100 ATM.
SEPARATOR
HEAT EXCHANGER
3000 Ft.
100 Ft.

FIG. 2. Estimate of size of thermonuclear power plant using present techniques.

An analysis of military, scientific, and commercial applications of space-flight systems from the point of view of assessing their business implications for the airframe industry.

# of Future Space Flight Systems

William H. Dorrance
Convair, A Division of General Dynamics Corporation

considered herein will unquestionably arise once our modest beginning becomes an accomplished fact.

The Confines of Space Flight in the Near Future

Descriptions of space-flight systems ranging from satellites of earth to systems involving excursions to galaxies other than our own can be found in the technical literature. A first attempt at evaluating business implications of such systems should begin by determining what is feasible using today's technology.

It has been said that the realization of space flight is tied in closely with the development of suitable power plants and propulsion systems.[2] Such has been the case for the development of aircraft and missiles, and, to a certain extent, such will be the case for space flight. However, the confines of space travel will also be determined to a certain extent by time as it is reckoned here on earth.

Fig. 1 shows the Milky Way, our galaxy in the universe, as it would appear from above its central plane. This representation has been determined using radio astronomy techniques in the 21 cm. wavelength region.[3] Note the astronomical dimension of the galaxy—a full 100,000 light years across. Even supposing the space vehicle could accelerate to a velocity close to the velocity of light, it would take the vehicle 200,000 earth years to make a round trip. It can be argued, using relativistic theory, that time would pass slowly for our intrepid astronaut(s) on the spaceship. Nevertheless ages go by on earth during the trip and there might be reasonable doubt that the solar system would exist upon return!

Of course, it might be proposed that an unmanned instrumented "space-time capsule" be dispatched on such a journey to bring back surprises for future generations. Then we ask what power plant is to be used? Tsien has assessed the technological feasibility of a thermonuclear power plant and his results are not too encouraging for spaceship considerations.[4] Fig. 2 illus-

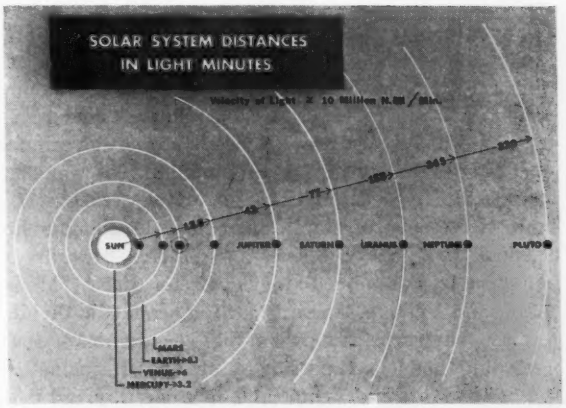


Fig. 3.

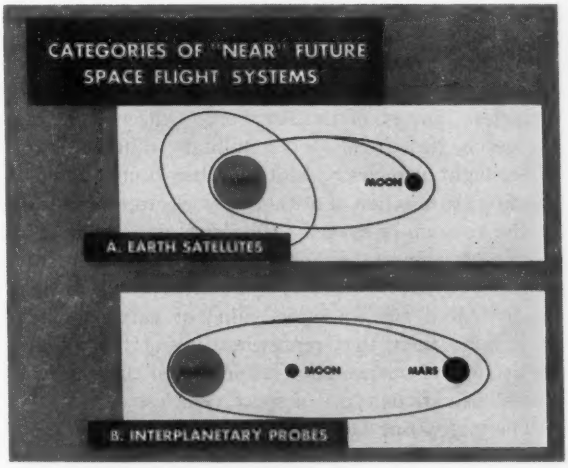


Fig. 4.

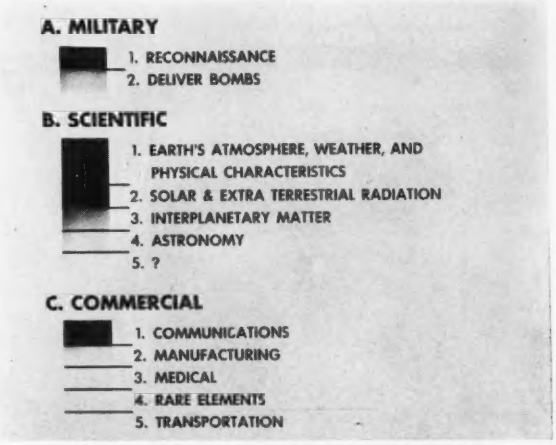


Fig. 5. Motivating factors for space-flight systems.

trates Tsien's Deuterium "burning" fusion power plant, the most startling feature of which is the tremendous size of the fusion chamber (300 ft. by 3,000 ft.). Use of plasma arcs, the catalytic effect of mu minus mesons or other currently unknown techniques or phenomena may reduce the foreseen size of fusion power plants but, for the present, this must remain in the realm of speculation.

It appears, then, that our space-flight systems are limited to our own Solar system. Fig. 3 shows the dimensions of this system in light minutes. Again we find that time, not necessarily technology, works against extended voyages through this system. The energy requirements to visit, say, Neptune are not an order of magnitude greater than those required to visit Mars, but the elapsed time is 50 times greater and exceeds the normal life span of man. So it appears that our immediate practical objectives are directed towards excursions in the immediate vicinity of Earth, Moon, Mars and Venus. These excursions could be divided into two categories as shown in Fig. 4—satellites of earth including those encompassing Moon, and interplanetary probes to Mars and Venus including one-way and two-way trips.

Motivating Factors for Space Flight

The writer was pleased to find that numerous authorities have speculated upon possible "uses" of space-flight vehicles. Davis, of the Air Force Office of Scientific Research, has dwelled upon military ramifications of space-flight vehicles.[5] Ridenour has been quoted regarding the creation of a whole new electronics industry in the vacuum of space.[6] Haviland[7] and Pierce[8] have discussed in detail the uses of earth satellites as an intercontinental television relay system. Newell[1] has concisely stated the scientific value of earth satellites. It is seen, then, that representatives of the military, industry, and science have all presented their cases for "uses" of various types of space vehicles.

The motivating factors for the development of space-flight systems are summarized on Fig. 5. The writer has exercised his opinion by ranking the relative strengths of the motives. The writer was guided in his ranking system by considerations of the technical feasibility of achieving the objective expressed in each motive using present-day technology. These rankings are indicated by the shading shown before each motive listed. It is apparent that in the writer's opinion strong motives exist for establishing space-flight systems in the minds of representatives of the military, sciences, and the industries.

Business Potential in Two Representative Space-Flight Systems

Two well-documented space-flight systems were chosen for cost estimation analysis. These were the intercontinental television relay system proposed by Pierce[8] and a four-man scientific-military satellite system proposed by Ehricke.[9]

Fig. 6 illustrates one of the intercontinental satellite television relay systems proposed by Pierce. Pierce calculated that if one placed four 100 ft. diameter aluminum spheres diametrically opposed in satellite orbits at 2200 nautical miles altitude, it would be possible to affect intercontinental television relay using 10 cm. wavelength radiation reflected from the spheres. Transmitter power required might be about 100 kv. with a 250 ft. diameter antenna dish. The spheres would weigh 400 lbs. each and, presumably, be collapsed during ascent. Crude calculations show that rocket boosters of large but feasible size could be used to accomplish the lift and velocity required.

Assuming that it might take 3 flights per sphere to accomplish the task and assuming a cost of 5 million dollars per rocket booster, it would seem that the entire job of designing, integrating, and firing the missiles might be done for somewhat less than a billion dollars. Fig. 7 shows a conservative estimated cost of 200 million dollars. Pierce points out that a trans-Atlantic coaxial cable, which yields much less flexibility, might

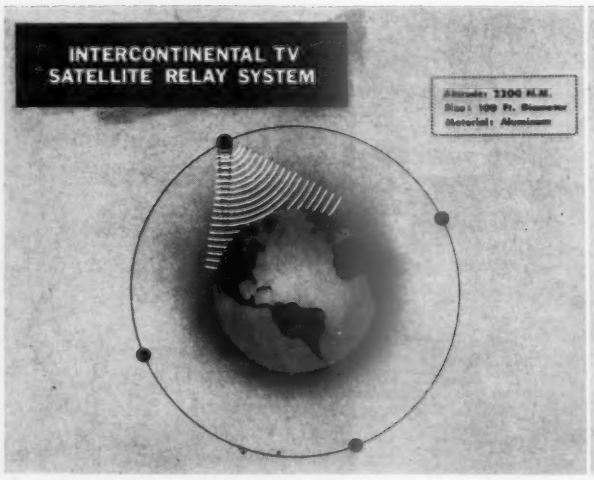


Fig. 6.

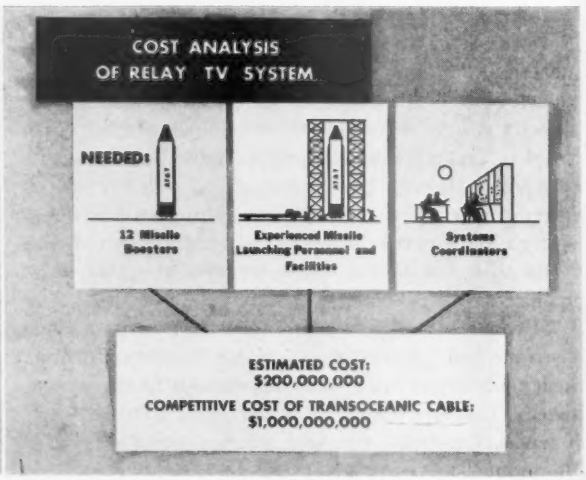


Fig. 7.

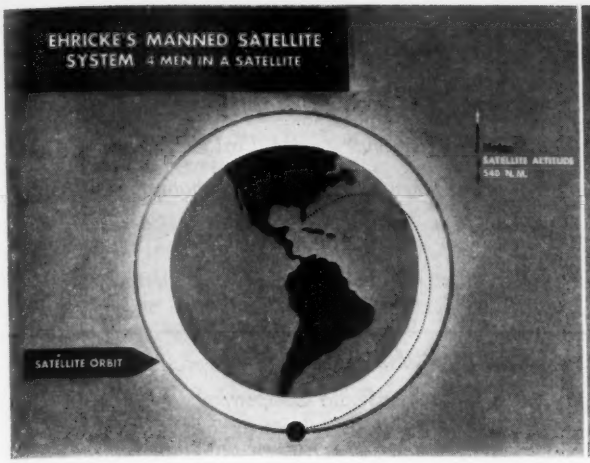


FIG. 8.

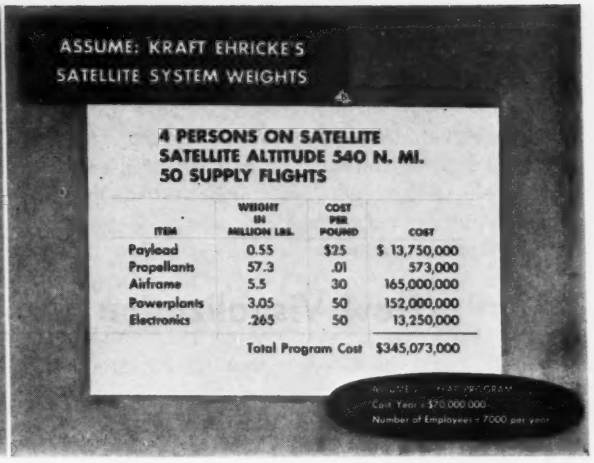

ASSUME: KRAFT EHRICKE'S SATELLITE SYSTEM WEIGHTS
4 PERSONS ON SATELLITE
SATELLITE ALTITUDE 540 N. MI.
50 SUPPLY FLIGHTS
ITEM | WEIGHT IN MILLION LBS. | COST PER POUND | COST
Payload | 0.55 | $25 | $ 13,750,000
Propellants | 57.3 | .01 | 573,000
Airframe | 5.5 | 30 | 165,000,000
Powerplants | 3.05 | 50 | 152,000,000
Electronics | .265 | 50 | 13,250,000
Total Program Cost $345,073,000

FIG. 9.

cost up to 1 billion dollars at today's prices. It is apparent that here is a case where a space-flight system could compete with the conventional communications techniques.

Ehricke's manned satellite system is illustrated in Fig. 8. Ehricke envisions establishing a 500,000-lb. manned satellite in an orbit at about 540 n. miles altitude and has calculated the hardware and equipment necessary for the task.[9] The writer used present-day cost-per-pound figures which, combined with Ehricke's weights, yield total system hardware costs. These costs are shown in Fig. 9.

As can be seen in Fig. 9, Ehricke's manned satellite represents an expenditure of about 345 million dollars in hardware alone. Not included are costs of research and development, test firings, and systems integration, which, to be sure, can be combined with other projects including military ones.

Thus, we see that two feasible space-flight systems of the "near" future (by near future the writer means within 10 to 25 years) cost less than 1 billion dollars apiece. This is much less than is currently being spent each year on aircraft and missiles by the Air Force alone.

CONCLUSIONS

It is possible to draw several conclusions from this study. Among these are:

(1) Near future space-flight systems will be limited to our Solar System by chemical propellents and considerations of "time-to-travel."

(2) Business potential of near future space-flight systems, based on present-day requirements, appears to be of the order of 1 billion dollars.

(3) The development of fusion or other presently undefined power plants could change the above conclusions.

(4) The onset of bonafide world peace could hasten the expenditures in space-flight systems and thus change the nature of activities in the airframe industry.

REFERENCES

[1] Newell, H. E., Jr., *Scientific Uses of an Artificial Earth Satellite*, Jet Propulsion, Vol. 25, No. 12, December, 1955.

[2] "Summary Session, Astronautics Symposium," AFOSR Report TR-57-14 AD 120-430, March, 1957.

[3] Kraus, John D., *The Radio Sky*, Scientific American, Vol. 195, No. 1, July, 1956.

[4] Tsien, A. S., *Thermonuclear Powerplants*, Jet Propulsion, Vol. 26, No. 7, July, 1956.

[5] Davis, W. O., *A New Approach to Spaceflight*, Missiles and Rockets, December, 1956.

[6] Steier, H. P., *ICBM Program May Trigger New Technology*, American Aviation, December 17, 1956.

[7] *Expert Charts Future of Big Brother Satellite*, contributed by R. P. Haviland, Missiles and Rockets, December, 1956.

[8] Pierce, I. R., *Orbital Radio Relays*, Jet Propulsion, Vol. 25. No. 4, April, 1955.

[9] Ehricke, Krafft A., *A New Supply System for Satellite Orbits, Parts 1 and 2*, Jet Propulsion, Vol. 24, No. 5 and Vol. 24, No. 6, September-October, 1954 and November-December, 1954.

NOW AVAILABLE

The National Midwestern Meeting—Weapons System Management Proceedings contains all *unclassified* papers presented at the meeting.

Member Price $1.50 **Nonmember Price $2.50**

An amplification of the author's remarks made at the Fifth International Aeronautical Conference, with prints taken from films of his studies.

Flow Visualization

A. M. Lippisch
Collins Radio Company

THE VISUAL observation of a flow process is an essential and often indispensable method for the experimental and theoretical investigation of flow phenomena. There are numerous examples of this kind which indicate that flow visualization is the key to the logical treatment of such problems.

The intensive aerodynamic research in the wind tunnel has put the emphasis on the force and pressure measurements for experimental investigation, and only in the supersonic flow regime does the visual observation by the Schlieren and Interference methods serve as a tool of research. It seems almost as if there is a certain prejudice against the visual flow investigation in the subsonic range, even though there are still several basic problems which could be investigated by the use of flow visualization. Apparently the visual observation methods in common use are not satisfactory for such purposes and do not give sufficiently detailed information of the flow field.

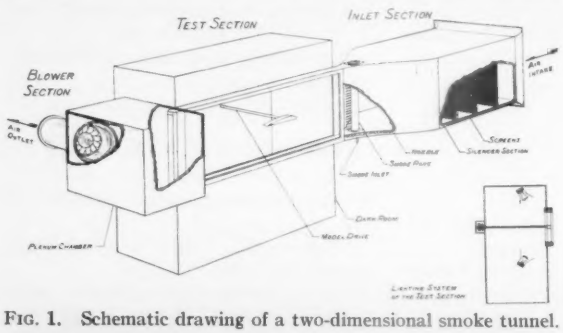


FIG. 1. Schematic drawing of a two-dimensional smoke tunnel.

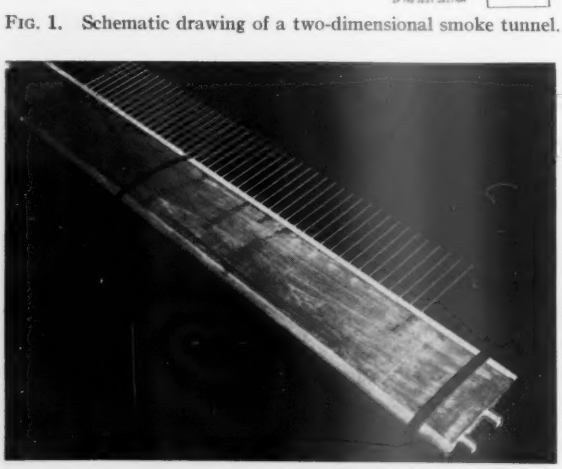


FIG. 2. Smoke rake.

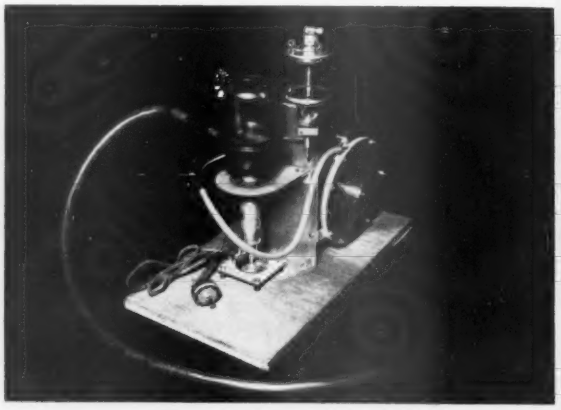


FIG. 3. Smoke generator.

However, besides using flow visualization for aerodynamic research, the teaching of aerodynamics can be facilitated to a large extent if a proper method of visual observation of the flow process is available. The initial development of the two-dimensional smoke tunnel was started with the aim of producing such a teaching aid for aerodynamics.

THE TWO-DIMENSIONAL SMOKE TUNNEL

The system originally used on the smoke tunnels of the DFS is, with some refinements, still the system of the two-dimensional tunnels for flow visualization which were developed by the Collins Aeronautical Research Laboratory under the sponsorship of the Office of Naval Research. These tunnels represent mainly two-dimensional low turbulence tunnels which are especially equipped with an arrangement to produce a row of smoke filaments to make the streamlines within the test section visible. Fig. 1 shows the general layout of a two-dimensional smoke tunnel of this type. The tun-

The author is Head of the Aeronautical Research Laboratory.

nel consists of three major parts: (1) the inlet and silencer chamber and the nozzle, (2) the test section, and (3) the diffuser or plenum chamber and the blower.

On some of our tunnels we placed the blower at the entrance to the tunnel to provide pressure instead of suction in the test section. This system facilitates the sealing problems of the test section. But we have found that, in order to make the slipstream from the blower free of turbulence, a large amount of the power has to be wasted, and the large plenum chamber between the blower and the tunnel itself takes more space than a suction-type tunnel.

To produce a flow free of turbulence within the test section, we have to use a large contraction in the nozzle and we have to install several fine-mesh wire screens across the silencer chamber. Even if one might not detect any disturbances with velocity measuring instruments, the smoke filaments will show the slightest irregularities, and great care must be taken to adjust the entrance part and to make proper corrections if necessary.

The main difficulty in the development of these 2-D smoke tunnels was to obtain a disturbance-free introduction of the smoke lines. The smoke rake (Fig. 2) from which the smoke is released through several fine tubes has to be located in the center of the nozzle where the velocity gradient stabilizes the flow over the strut and the smoke tubes. It is obvious that the shape of the nozzle has to be held within close tolerances to obtain this flow condition.

Occasionally smoke lines have been used for certain flow investigations. But usually these lines disintegrate quickly, and the flow pattern cannot be seen clearly over a large length of the streamlines. With the arrangement we developed, undisturbed smoke lines of several feet in length can be obtained.

Originally, we used smoke produced by burning rotted wood. The visibility of such smoke is extremely good, but the tar residue makes frequent cleaning of the lines necessary, and the smoke generator with the radiator and filter is quite cumbersome. Therefore, when building our new tunnels, we used the smoke generator developed by Preston (R&M No. 2023) which uses a method of oil evaporation to produce a fine oil mist. This method is much more practical, and we now use an improved smoke generator based on the same principle of evaporation of oil (Fig. 3).

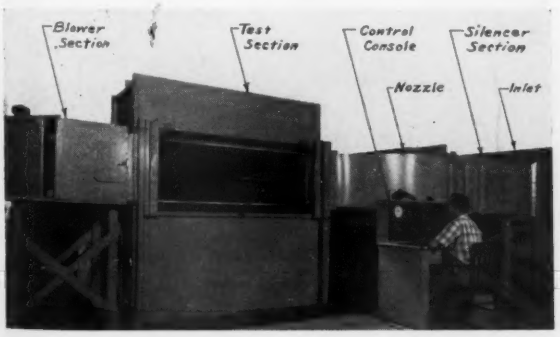


FIG. 4. General view of a two-dimensional smoke tunnel in operation.

The test section of the tunnel is enclosed between two glass walls which are 1 to 3 in. apart, depending on the size of the tunnel. The view field is lighted by two rows of strong lights behind the top and the bottom of the frame of the test section. To secure good visibility of the smoke lines, a larger "dark room" is located behind the test section. The walls of this room are covered with black velvet.

The models are attached through a hole in the rear glass wall. The model drive, which usually permits three separate motions, consists of three concentric tubes which extend behind the rear wall of the dark room. The model positions can be adjusted from a control panel which is equipped with additional instruments for tunnel control and velocity measurement (Fig. 4). The flow from the test field enters a plenum chamber from which it is sucked away by the blower. Since, at this stage, the air is mixed with smoke, it cannot be returned.

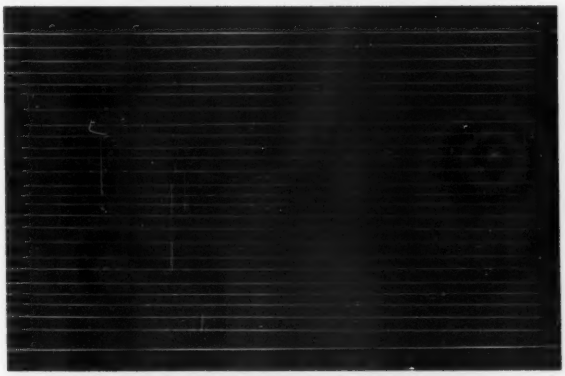


FIG. 5. Plain flow in the test field.

The plain flow in the test field represents a parallel flow of which the visible lines are $1–1^1/_2$ in. apart. These lines are clearly visible for a length of 4–6 ft. (Fig. 5). The speed limit of clear visibility depends on the contraction ratio of the nozzle. With a ratio of

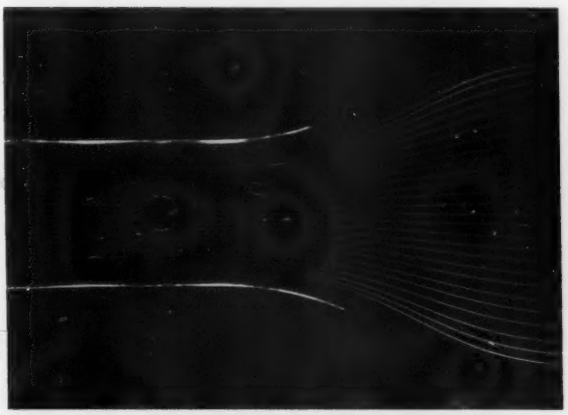


FIG. 6. Accelerated flow through a nozzle.

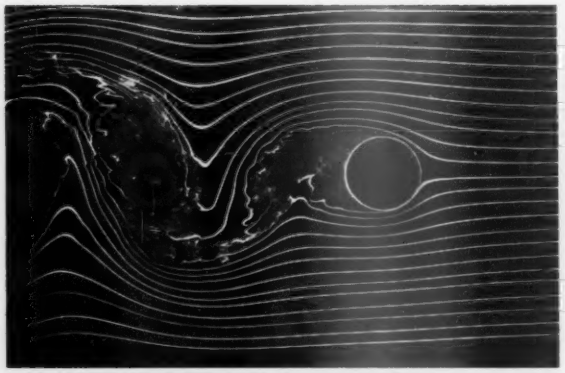


FIG. 7. High-speed picture of the development of a vortex street behind a circular cylinder.

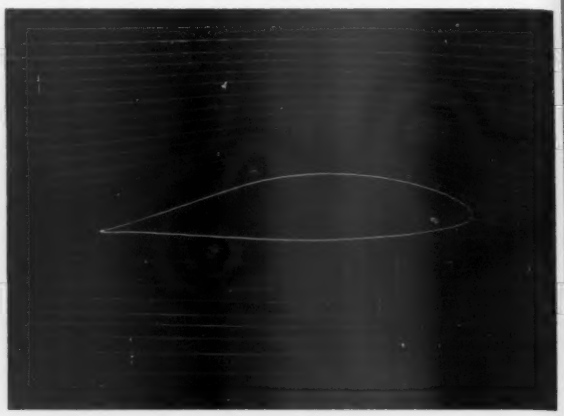


FIG. 10. Flow around a low drag NACA section.

FIG. 8. Flow around a wing section at $-2°$ angle of attack.

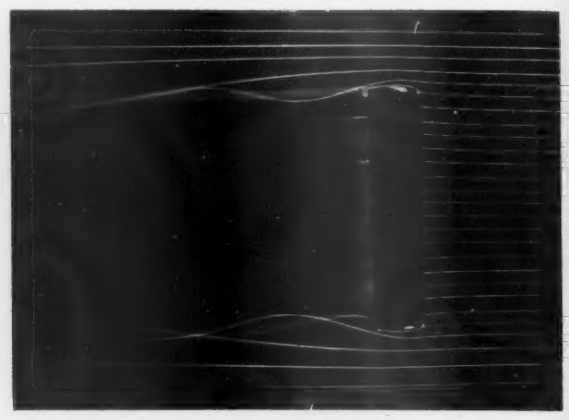


FIG. 11. Tip vortex formation on a straight wing.

FIG. 9. Flow around a wing section at $+5°$ angle of attack.

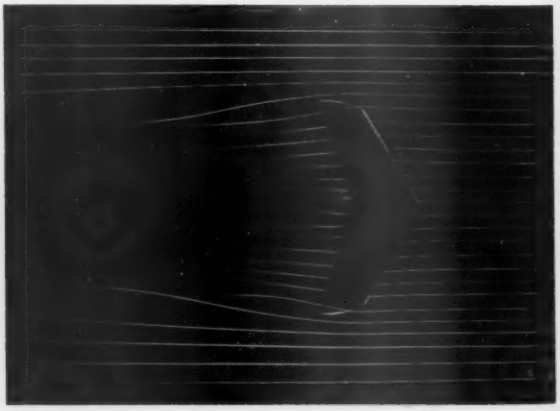


FIG. 12. Flow over a sweptback wing.

1:20 we can produce good visibility up to 80 ft. per sec.

We have found that large contraction in two or more separate steps makes it possible to obtain distinct flow lines at much higher speeds (Fig. 6). There is certainly no technical limit to the speeds at the test section; but in order to obtain a view field of reasonable size, the tunnel entrance part must become quite large. It is therefore mainly a question of space to build tunnels of such systems for high-speed flow investigations.

Methods of Testing

The testing of a specific model consists in the visual observation of the flow under different conditions, the photographic recording of the flow pattern, and measurements of the velocity field, the pressure distribution, and wake surveys.

In many cases the visual observation of a certain phenomenon gives sufficient information for further aerodynamic investigations. But it often occurs that the flow pattern cannot be observed clearly because of the high velocity of the motion. It is, therefore, necessary to make a high-speed film recording of a particular setting. With special lighting of the test field, we can make high-speed film recordings up to nearly 2,000 frames per sec. These are mostly photographic problems, and one needs some experience to obtain good visibility of the flow lines. With modern high-speed films and proper lighting of the test section, quite satisfactory results can be obtained. Fig. 7 shows such a high-speed picture of the development of a Kármán vortex street behind a circular cylinder.

Pictures taken with normal exposures show the flow pattern around the model without the particular turbulence structure in regions of separation. Such examples are useful in comparison with the theoretical treatment or investigations concerned with the potential flow around a certain model. Figs. 8, 9, and 10 show a few examples. Figs. 8 and 9 represent the flow field around a normal wing section at two different angles of attack. Fig. 10 shows the flow on a low drag airfoil of the NACA series. The small disturbance produced by such a wing section can be clearly observed.

For the purpose of demonstrating three-dimensional flow phenomena, we can also simulate some of these flow patterns. For example, we can show the formation of the wing tip vortices on a model wing. The model is mounted at the center plane between the two walls, and we see a flow picture as if we would look on top of the wing (Fig. 11). We can control the angle of attack and the yaw angle during the test. Such experiments will serve mainly as illustrations to facilitate the understanding of the theoretical treatment. Fig. 12 shows a swept-wing model, and we can observe the change in the direction of the flow on the surface of the wing.

The presentation of the basic flow configurations is extremely helpful to bring about an understanding of the aerodynamic problems, and it has been found that such visual presentation makes it possible to cover a large field of problems in a short time without much difficulty. If we use the smoke tunnel for the experimental investigation of a particular problem, we usually want to measure certain properties of the flow which is demonstrated by the flow picture we are observing. What methods can be applied for such scientific tests?

If we take, for example, the test of the flow conditions

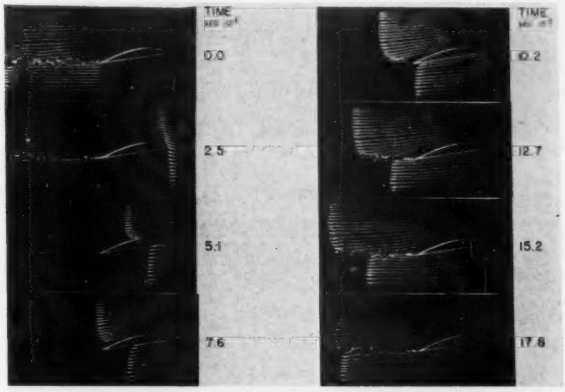


Fig. 13. Sequence photographs of time lines on a wing section with lift (reproduction from a high-speed film).

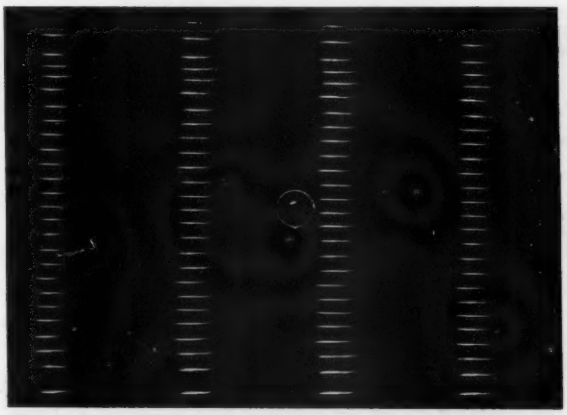


Fig. 14. Multiexposure of time line at plain flow.

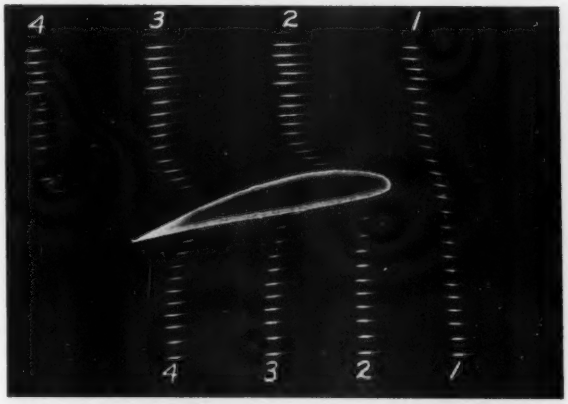


Fig. 15. Multiexposure of time line of a flow over a wing section. (It should be observed that the upper and lower branches of the same time line are largely offset. Equal numbers identify equal time line position.)

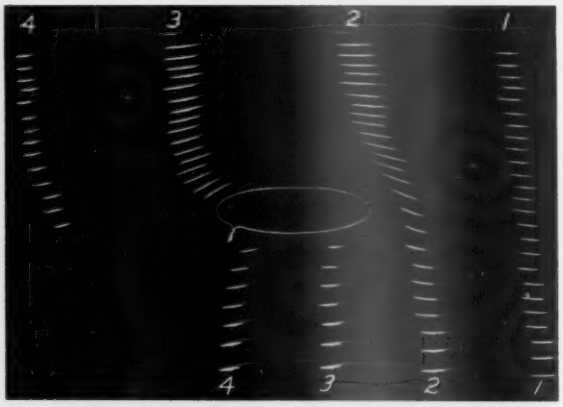


FIG. 16. Multiexposure of time line on a supercirculation section. (Branches of the same time line have equal numbers.)

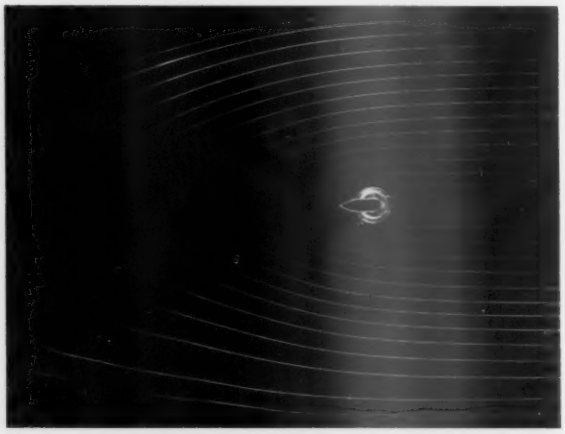


FIG. 17. Two-dimensional jet stream in a parallel flow field.

FIG. 18. Flow around ducted section without internal propulsion.

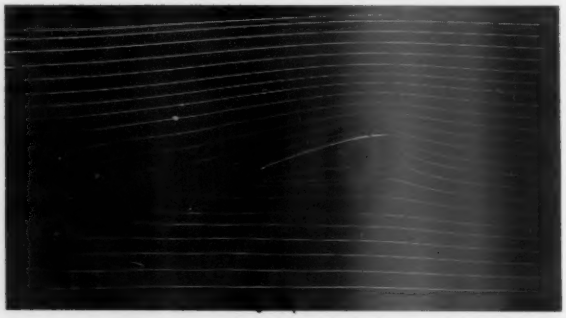


FIG. 19. Same test conditions as on Fig. 18 but with internal propulsion.

on a certain wing section, we can first of all make pictures of the flow field under different test conditions such as different angles of attack, different flap deflections, or other systematic changes. We can provide such a model with a multitude of pressure taps and measure simultaneously the pressure distribution which corresponds to a flow picture. We can also measure the drag with the momentum method and determine the lift from pressure recordings along the upper and lower tunnel wall.

It is obvious that such investigations require considerable time for preparation of the models and for the measurement and its evaluation. But it often happens that the test is intended to serve the purpose of improving a certain arrangement by successive tests of different configurations and alterations of the model. In order to record each step of the test series, the flow picture will not serve the whole purpose, and we need at least a record which makes it possible to evaluate the velocity distribution of the flow. We could do this by measuring the distance between the streamlines at different points. This method is inaccurate and also time consuming.

We succeeded in developing a much superior method of determining the velocity field around the model. This method of evaluation is called the recording of the time lines. The technique is the following: Instead of having a continuous flow of smoke from the smoke rake, we release the smoke periodically so that each of the pulses produces a smoke front of small puffs which travels through the test field. With proper arrangement of the mechanical devices, the smoke front under undisturbed conditions is a vertical line of small dots where each of those dots travels along the corresponding streamline.

Since we have released the puffs at the same time, the line at any station of the test field represents the position of particles of the initial parallel flow after a certain lapse of time. If we take a high-speed moving picture of such a "time line" while it travels through the test field, we obtain a direct record of the velocity distribution around the model.

The shape of the time lines also gives an indication of the lift produced by a wing section, and we can by comparison determine the change of the circulation from the changes of the model settings (Fig. 13). Since we can derive the course of the time lines from the theoretical computation of the flow field, we are able to compare the experimental result with the ideal flow pattern.

With the use of a special photographic method, we made it possible to obtain a picture of a certain test which shows the position of the time line for a series of equal time intervals. This is done by a multiexposure of the negative at fixed time intervals. The pictures shown with this article represent the first results with this new method of photographic recording. This technique can be developed further and will serve as an extremely useful tool in two-dimensional flow investigations (Figs. 14, 15, and 16).

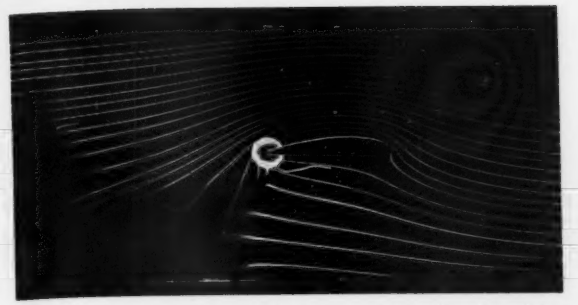


FIG. 20. Wing section with jet flap. (The direction of the jet stream is indicated by the finger on the circular attachment behind the rear glass wall.)

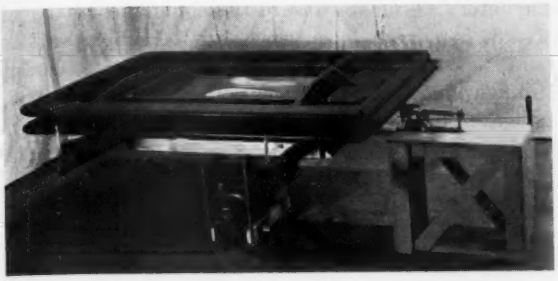


FIG. 21. Two-dimensional flow table for testing jet-induced flow configurations.

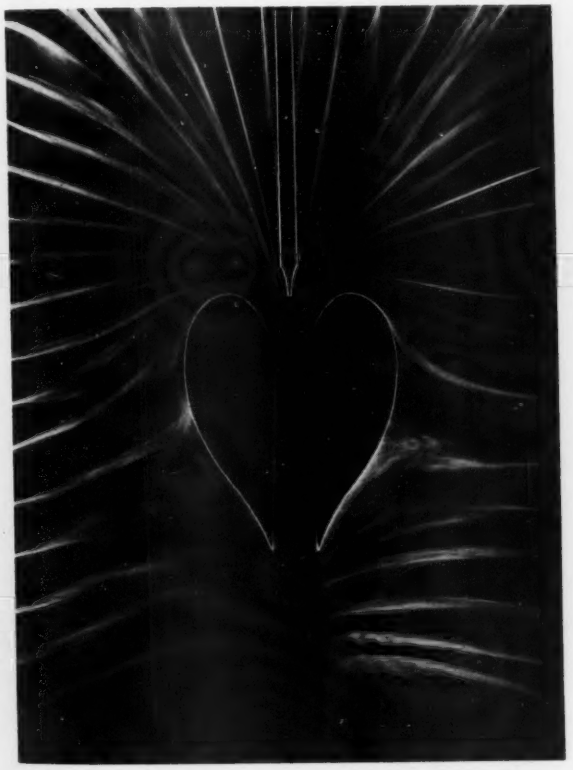


FIG. 23. Induced flow on an augmenter configuration. The jet stream is discharged from the nozzle in the center of the inlet.

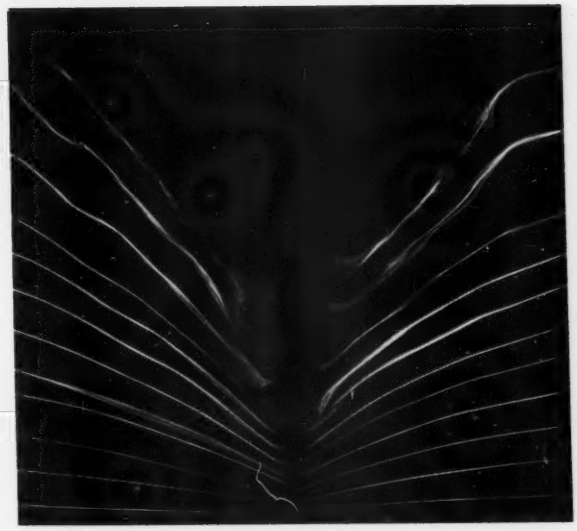


FIG. 22. Two-dimensional jet stream discharging perpendicular to a straight wall.

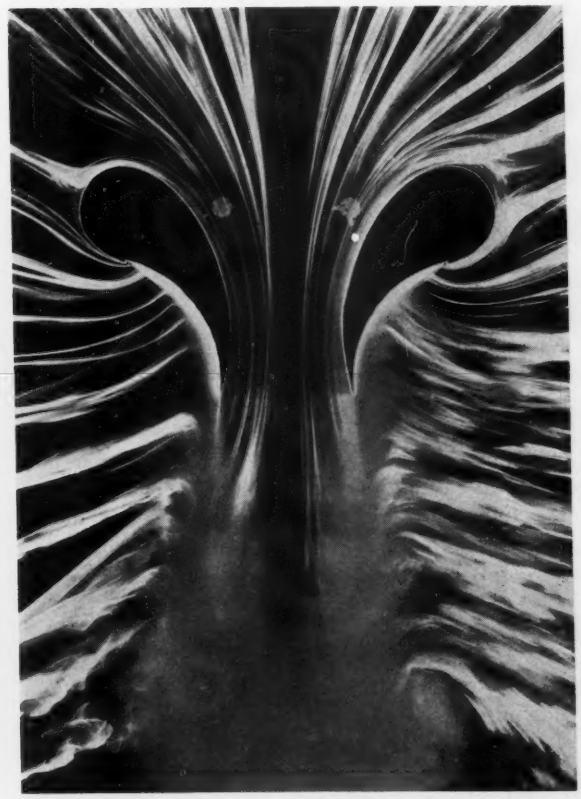


FIG. 24. Pumping action of two jet streams on the outside of a two-dimensional nozzle.

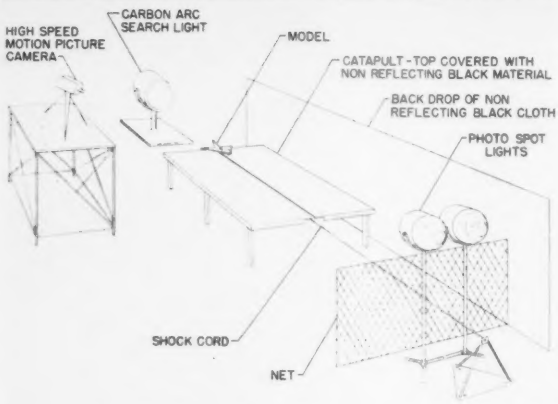


FIG. 25. Test arrangement for flow visualization on free flight models.

Before describing other methods of flow visualization, we would like to show some of the results of the experiments which illustrate the influence of a jet stream on a flow field. We first investigated the action of a jet stream released into a parallel flow field in the direction of the initial flow (Fig. 17). The picture clearly shows that the jet stream through its boundaries induces a motion of the outer flow toward the boundaries. The deviation of the outer streamlines shows that there is a low-pressure area along the jet boundary which causes the outer flow to go into this boundary and finally to mix with the jet stream.

While the turbulent mixture in the jet is pretty well explained, the jet-induced outer flow has not been investigated, and it was assumed that there was no pressure differential throughout the whole field. Actually the jet stream accelerates the flow in its vicinity—an effect which stabilizes the flow around a body from which the jet stream is released. This can well be seen on the flow picture of a shrouded jet which is shown with and without the action of the jet inside the flow channel (Figs. 18 and 19). We have also tested the action of a jet stream from the trailing edge of a wing section. Such arrangements are now known as the "jet-flap" (Fig. 20).

The necessity to investigate the jet-induced flow under static conditions—i.e., under the condition of no outer initial flow—led to the design of a special device to visualize such flow patterns. We call this instrument a flow table (Fig. 21).

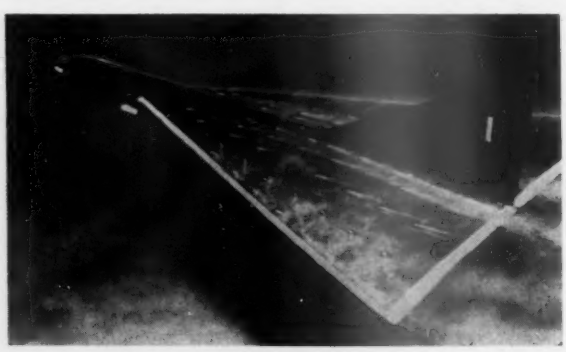


FIG. 26. Delta wing model with flow visualization in flight.

The flow table represents a two-dimensional flow tunnel with open sides placed in a horizontal position. The rim of the test field is fitted with a well-rounded inlet and, along the inlet, tubes are located from which smoke can be released. We have used these flow tables for the investigation of thrust augmenter arrangements and for the testing of some classical examples of jet-induced flow fields. There is, for instance, the well-known example of a jet stream released normal to a straight wall. Because of the assumption of constant static pressure throughout the field, the inflow of the outer air toward the jet was thought to be a parallel flow from both sides parallel to the wall.

Our tests, which simulated this example, showed that the outer flow moves toward the boundaries of the jet stream in curved lines which can be represented as parabolas with their focus at the location of the slot through which the jet stream is released (Fig. 22). Before the outer air reaches the boundaries of the jet stream, its total head is constant and equal to P_0. The flow must therefore be a potential flow, and it should be possible to derive the stream function of the outer flow field. Using the well-known flow potential $v = z^{1/2}$ as the vortex sheet which represents the jet boundary, we found that the theoretical computation of the outer flow is in close agreement with our experimental results.

The induced flow of a jet stream without the wall shows a similar parabolic motion of the flow lines. If we superimpose an outer parallel flow, we obtain a theoretical presentation which shows a flow pattern similar to the test result of the flow induced by a jet stream as we have shown before in Fig. 17.

Many other interesting tests can be made with the help of a flow table, and we have shown some of those tests in the Figs. 23 and 24.

It must be said that the flow phenomena concerned with the flow induced by a jet stream are not properly understood and that these investigations offer a wide field for theoretical and experimental investigation.

Flow Visualization of Three-Dimensional Flow Patterns

Several problems in aerodynamics cannot be reduced into a two-dimensional form, and it is then necessary to investigate the flow pattern under three-dimensional flow conditions. For this purpose we have used two methods of flow visualization: (1) on free flight models and (2) in a low-turbulence wind tunnel.

The observations on models in flight were obtained in the following way: The model contained a simple smoke generator using titanium tetrachloride. Through an inlet, air was blown over a layer of cotton saturated with the fluid. The smoke produced in this way entered the hollow inside of the model and was released through holes at different points of the surface. During its flight through a dark room, the model was

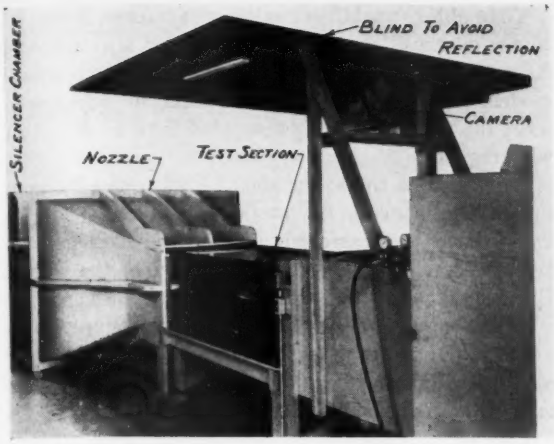


FIG. 27. Low-turbulence wind tunnel for tests of three-dimensional flow visualization.

FIG. 28. Normal speed photograph of the flow over a straight wing.

FIG. 31. High-speed photograph of the boundary-layer formation on a tapered sweptback wing.

FIG. 29. Flow around the wing tip of a straight wing (Fig. 28) to show the tip vortex formation. (The vortex core is indicated by the dark line in the center of vortex.)

FIG. 30. High-speed photograph of the boundary layer and tip-vortex flow on a straight wing.

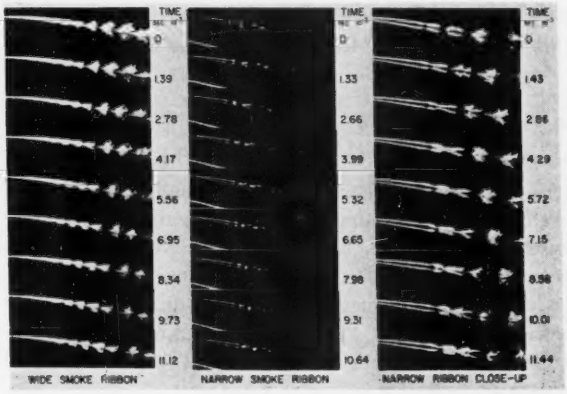


FIG. 32. Sequence photographs reproduced from a high-speed film recording of the boundary-layer transition on the upper rear surface of an airfoil. The smoke ribbon is reflected from the polished surface, and the smoke ribbon and its image are recorded.

FIG. 33. Photographic record of the tip vortex and the wake behind a straight wing (Fig. 28).

lighted by strong search lights from the rear or from the front and the search lights were placed in such a way that the light beam was mainly on the longitudinal axis of the model. This system of lighting is necessary to obtain a good visualization of the flow over the surface and to prevent reflection from the surface of the model. Otherwise, even with models painted in black, this reflection is so strong that the smoke lines cannot be identified clearly.

During its flight the model is photographed with a high-speed film camera. This method is especially useful when certain transient flow conditions are to be investigated. The pictures show a test setup and a reproduction from the film recording (Figs. 25 and 26).

A large platform with a catapult underneath was used for the launching of the model. The model support was designed to obtain minimum obstruction of the flow on the model during the launching period. In this way we intended to obtain preliminary information of the transient flow during the acceleration period. It was planned to use larger models at a final stage of this work.

The tests we made have shown that such observation of a free-flight model is possible, and certain problems, especially in the low-speed range, can be investigated. The necessity to use dense smoke produced from chemicals makes it impossible to lead the smoke through fine tubes. When released on the surface, the smoke line is therefore not free of turbulence and disintegrates quickly. Nevertheless this method is often more useful than investigations with wool tufts since the smoke also shows the vortex configuration behind the model and the trail of the wake.

Three-Dimensional Tunnel for Flow Observation

To test the models used in the free-flight experiments, we built a closed tunnel with a rectangular cross section of 2 by 3 ft. This tunnel was later considerably improved with respect to its turbulence level in order to be used for testing methods of three-dimensional flow visualization. Fig. 27 shows this tunnel as it is installed in the Collins Aeronautical Research Laboratory.

The system is not much different from any low-turbulence tunnel. The contraction ratio here is 7:1, which is not as large as the contraction ratio of the 2D smoke tunnels. Therefore, we cannot use higher velocities without raising the turbulence level.

Usually we have seven fine-mesh wire screens in the silencer chamber. The nozzle leads the air into the test field which is covered with plate glass walls on two sides, while the other walls are used for the mounting of the model and as background for the photographic recording.

The diffuser behind the test field leads into a plenum chamber which is connected with the blower. Care must be taken to avoid any vibration from the blower to project into the diffuser and the test section.

To be able to use larger models, we attached the model to one side wall so that only one half of a wing model is in the test field. In this way the wing tip of the models was near the center of the tunnel in order to observe the most interesting flow conditions in this outer wing region.

We first tried to use the smoke lines released from a smoke rake located in the nozzle of the tunnel. But we found that it was extremely difficult to get this smoke into the boundary layer on the surface of the model. Since the flow in front of the model is induced by the lift distribution on the model, the streamlines which would come into the stagnation line along the leading edge of the model are usually not originated in a horizontal flow plane at the entrance of the test field.

Since we were mostly interested in the observation of the flow over the surface of the wing models, we released the smoke from the model itself through fine holes on the leading edge of the wing. The speed in this region of the wing surface is below the normal speed in the tunnel, and there is further acceleration of the surface flow on the upper surface. The smoke lines which float out with low velocity are, therefore, stabilized and are clearly visible as long as the boundary-layer flow is laminar. We then see a sudden transition and a following disintegration of the distinct lines in the turbulent part of the surface flow (Figs. 28 and 29). The process of the boundary-layer transition is too fast to be observed by the naked eye or the moving film recording with normal speed. But with a strobe light or with high-speed moving pictures, the flow phenomena in the region of transition can be observed well. The short-duration photoflash picture also gives good results, and we can observe the particular structure of the surface flow very clearly.

With carefully produced models it can be seen that, in all cases which we have observed, the transition takes place along straight lines which are parallel to the leading edge of the model. Figs. 30 and 31 illustrate this observation.

We can observe the beginning oscillation of the laminar flow—that means, the so-called Tollmien-Schlichting waves—and the following transition due to the instability of the wave motion. To observe such boundary-layer transition in detail, we have made a high-speed film of a single smoke ribbon floating over the upper surface of a 20-in. chord wing which spanned the tunnel from wall to wall. Fig. 32 is a reproduction from this film which was taken at around 3,400 frames per sec.

This film was made for the purpose of testing the possibility of the high-speed recording of the boundary-layer transition in detail. We intend to continue this most valuable boundary-layer visualization under different conditions and to show also the transition on a sweptback wing model.

Another interesting part of the three-dimensional flow visualization is the observation of the flow conditions around the wing tip. The formation of the wing-

(*Continued on page 36*)

Experimental investigation revealed that the fuselage nose, rather than the wing, is the major source of autorotative moment. Cross-sectional shape, surface roughness, and Reynolds Number were also found to have large effects on spin behavior.

Autorotation of Fuselages

Mark H. Clarkson
Chance Vought Aircraft, Incorporated

SYMBOLS

b	= wing span
$C_n = N/qSb$	= spinning moment coefficient
N	= moment about the spin axis
q	= dynamic pressure
R.N.	= Reynolds Number based on maximum width of fuselage
S	= wing area
V	= free-stream velocity
α	= angle of attack of complete model, referred to the mean geometric chord of the wing
α_l	= local angle of attack of fuselage section, referred to the vertical centerline of the particular section
ϕ	= bank angle, defined as the angle between the body y-axis and a horizontal plane, positive direction right-hand wing down
$\Omega = \omega b/2V$	= nondimensional rate of rotation, positive rotation clockwise as viewed by the pilot
ω	= spin rate, rad./sec.

THE SPIN BEHAVIOR of modern fighter-type aircraft has been of increasing concern. Spin tunnel tests and, it is believed in some cases, flight tests have indicated the existence of flat spins (mean angle of attack 80 to 85 deg.).

This paper presents the results of an exploratory investigation of the source of the autorotative moment in a flat spin where the spin axis passes relatively close to the center of gravity of the airplane. This investigation was begun in October, 1956, and was carried out in the Chance Vought Low Speed Wind Tunnel.

The tests were divided into three parts:

(1) Exploratory one degree of freedom tests of a complete model.

(2) Two-dimensional force and pressure distribution tests on two cylinders having typical fuselage cross-sectional shape.

(3) Determination of autorotation moments for a complete model in one degree of freedom tests.

This paper was presented at the Design Aerodynamics Session, IAS 26th Annual Meeting, N.Y., Jan. 27-30, 1958. (IAS Preprint No. 770.)

The author is Supervisor, Theoretical Aerodynamics Group.

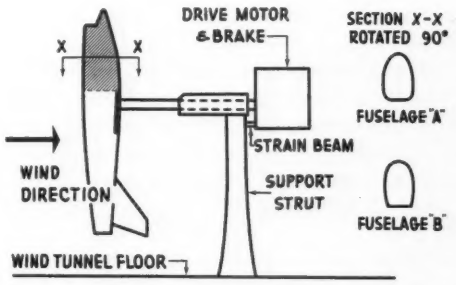


FIG. 1. Schematic of test setup for measuring autorotation moments.

A schematic of the setup for tests (1) and (3) is shown in Fig. 1. For moment measurements, both a drive motor and a brake are required since the model drives or is driven according to whether the moments are autorotative or damping. The moments were measured by a strain gage located as shown. For the first series of tests, only a brake was provided. Provision was made for locating the spin axis at any point from 10 to 28 per cent of the mean geometric chord of the model. Angle of attack was adjustable from 45 to 90 deg. and bank angle from zero to 15 deg.

EXPLORATORY ONE DEGREE OF FREEDOM TESTS

Before these tests were carried out, it was conjectured that the driving force for autorotation in a flat spin was due to bank angle since the conventional explanation for autorotation of wings did not fit the flat-spin case. Since some flat spins observed in the spin tunnel were steady and the spin axis was near the center of gravity, it was felt that a one degree of freedom test was sufficiently representative for the purpose in mind.

For the first test, on a model with fuselage "A," a bank angle of 5 deg. was tried with the model at an angle of attack of 90 deg. The direction of rotation was opposite that expected, and, when the model was given an initial rotation in the expected direction, it continued to autorotate in that direction also. Although bank angle had an effect, it was obvious it was not the cause of autorotation. Tests on the fuselage alone yielded rates of rotation 2.5 times as great as those for the complete model. When the fuselage was placed in a position corresponding to an inverted flat spin, it would not autorotate. It was concluded from

XUM

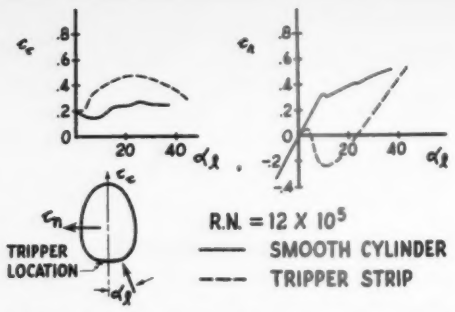


FIG. 2. Chord and normal force characteristics of cylinder with cross section "A."

these supplementary tests that the fuselage was the source of the autorotation and that the cross-sectional shape of the nose on the particular model was of primary importance. The importance of cross-section shape of the fuselage on prospin moments was perhaps first noted by the authors of reference 1.

TWO-DIMENSIONAL TESTS

For a fuselage to behave somewhat like a windmilling propeller, some rather unusual aerodynamic characteristics are required. To obtain further insight into this behavior, two cylinders were constructed with cross sections "A" and "B" as shown in Fig. 1, and force tests were conducted on them. The chord of these cylinders was 1 ft.

The chord and normal force coefficients obtained on cylinder "A" are shown in Fig. 2. It can be seen that the normal force curve is positive for the smooth cylinder for all positive angles of attack and negative for positive angles of attack between 5 and 24 deg. when a tripper strip of #80 aluminum oxide cloth was applied in the position shown in Fig. 2. A negative force for a positive angle of attack is an autorotative condition. Other results on cylinder "A," in addition to those shown, indicated a high degree of sensitivity to surface roughness. In general, increasing amounts of roughness tended to increase the autorotative tendencies.

The chord and normal force coefficients obtained on cylinder "B," which has somewhat sharper corners than cylinder "A," are shown in Fig. 3. It can be seen that a positive angle of attack yields a negative normal force up to about 30 deg A tuft and tuft probe investigation indicated a flow pattern similar to that shown in Fig. 4. From this sketch it can be seen that the flow separates at or near the forward corner on the downwind side but adheres to the surface on the upwind side. It would be expected that a negative pressure peak would develop on the upwind side and such is the case, as can be seen from the pressure distribution shown in Fig. 5. Cylinder "B" was found to be relatively insensitive to roughness and Reynolds Numbers effects within the range of Reynolds Numbers tested.

It is apparent from the foregoing that the autorotation of fuselages is intimately connected with flow separation and thus subject to all the vagaries of such phenomena.

Somewhat similar force test results are reported in reference 2. It is understood that the characteristics reported on here for blunt airfoils have been used to explain the oscillation of ice-coated telephone wires and electric cables.

DETERMINATION OF AUTOROTATION MOMENTS OF A COMPLETE MODEL

Having determined the general nature of autorotation of fuselages, it was decided to make relatively careful experiments on a complete model with particular care being taken with the surface finish of the fuselage. A schematic of the system used to measure the autorotative moments is shown in Fig. 1. The size of the model was selected so that the range of Reynolds Numbers available, based on the maximum fuselage width, would bracket 150,000, which is in the neighborhood of the critical Reynolds Number expected for a smooth circular cylinder in the CVA tunnel. The effect of Reynolds Number on spinning moment coefficient is shown in Fig. 6 for fuselage "A." On this and the following figures, values of C_n lying in the first quadrant are prospin or autorotative moments, and values of C_n lying in the fourth quadrant are damping moments. It can be seen that what may be considered as a critical Reynolds Number exists for this particular model of about 270,000. Conventional spin tunnel tests are carried out at Reynolds Numbers lying in the subcritical range obtained for fuselage "A."

To evaluate the effect of surface roughness, tests were run with two sizes of carborundum grit sprinkled on the lower part of the fuselage with average diameters of 0.001 and 0.0085 in. respectively. The results are shown in Fig. 7. Apparently, roughness of the size tested caused earlier separation of the flow on the downwind side of the fuselage.

Fuselage "B," however, exhibited relative insensitivity to variations in Reynolds Number and roughness in the ranges tested. For this reason, results from tests on fuselage "B" are used to show the major aspects of the effects of angle of bank and angle of attack

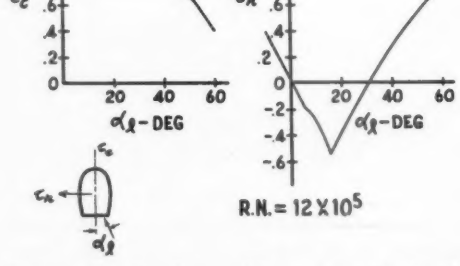


FIG. 3. Chord and normal force characteristics of cylinder with cross section "B."

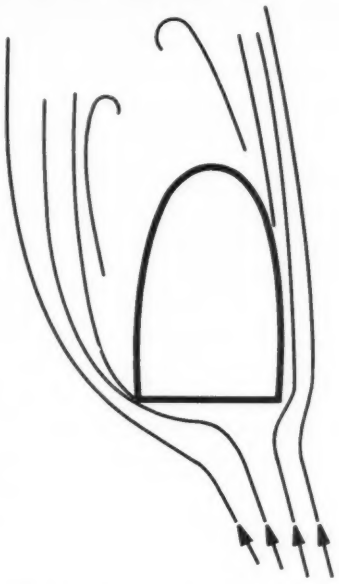


FIG. 4. Flow pattern for autorotation.

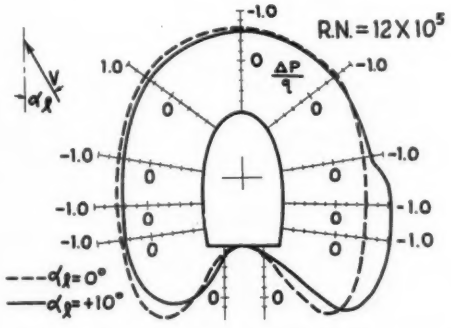


FIG. 5. Pressure distribution on cylinder with cross section "B."

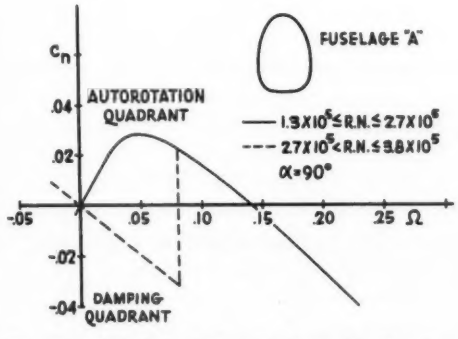


FIG. 6. Variation of C_n with Reynolds Number, fuselage "A."

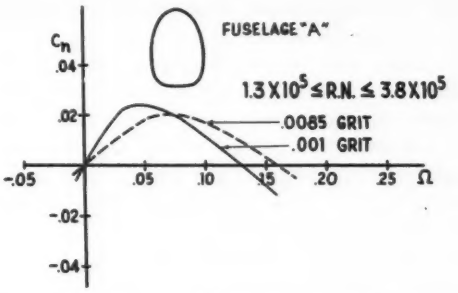


FIG. 7. Effect of roughness on C_n, fuselage "A."

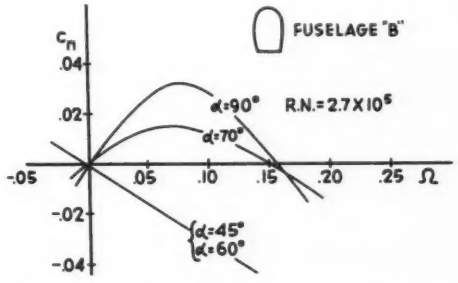


FIG. 8. Effect of angle of attack on C_n, fuselage "B."

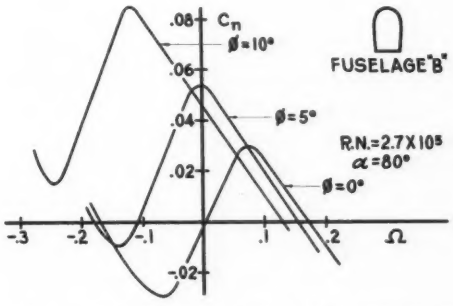


FIG. 9. Effect of angle of bank on C_n, fuselage "B."

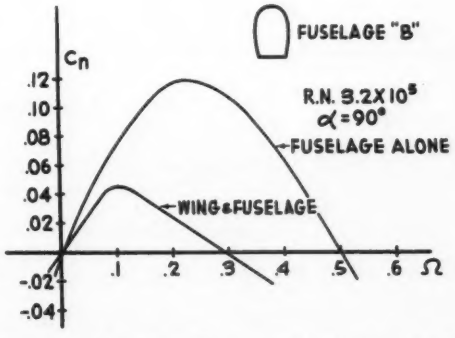


FIG. 10. Damping effect of wing, fuselage "B."

of the complete model on the spinning moment. The effect of angle of attack is shown in Fig. 8 where it can be seen that autorotation ceases at an angle of attack of about 65 deg.

The main effect of bank angle appears to be due to the increment in local fuselage angle of attack, equal to the angle of bank, along the fuselage nose. This is evidenced by the relatively powerful clockwise moment at zero rate of rotation for positive bank angles as shown in Fig. 9. The contribution of the wing due to bank angle is in the opposite direction.

That the fuselage is the predominant source of the autorotative moment is shown rather conclusively in Fig. 10 where the spinning moments of the wing-body and body alone are compared. It can be seen that the wing provides quite large antispin moments.

Conclusions

The main conclusions reached from this investigation are as follows:

(1) Autorotation for the models tested was found to be due to an aerodynamic side force originating on the fuselage nose.

(2) The autorotation moment was found to be intimately connected with flow separation and therefore sensitive to surface roughness, Reynolds Number, and the cross-sectional shape of the fuselage.

(3) Means need to be developed for correlating spinning moments at spin tunnel Reynolds Numbers with flight Reynolds Numbers and/or means need to be developed for conducting model spin tests at or near flight Reynolds Numbers.

References

[1] Irving, H. B., Batson, A. S., and Warsap, J. H., *Contribution of Body and Tail of an Aeroplane to the Yawing Moment in a Spin*, British R&M No. 1689, November, 1935.

[2] Neihouse, A. I., Klinar, J. J., and Scher, S. H., *Status of Spin Research for Recent Airplane Designs*, NACA RM L57F12, August, 1957.

✦ ✦ ✦

Flow Visualization *(Continued from page 32)*

tip vortex and its influence on the boundary layer of the adjacent parts of the outer wing surface can be observed well, and the particular shape of this part of the wing certainly needs more attention. We can observe the influence of a wing-tip tank on the vortex formation, and many other tests can be performed to obtain an extended knowledge about the flow conditions on specially designed tip configurations.

It is also possible to trace the course of the tip vortex behind the wing if we light the wake in a thin layer perpendicular to the flow direction. Fig. 33 shows such a picture of the cross-section through the wake. To obtain enough light for such photographic recording, we led sunlight into the laboratory through mirrors and then directed it into the tunnel through a narrow slot perpendicular to the side wall.

Other investigations were concerned with the three-dimensional lifting flow around bodies of streamline shape. In addition to such tests, we have visualized the flow patterns on shrouded propellers and similar systems of a mixed internal and external flow.

Since this paper is intended to give only a description of the different methods of flow visualization, the results of the test will be given in a separate report.

Bibliography

Lippisch, A., *Results from the Deutsche Forschungsanstalt für Segelflug Smoke Tunnel*, Journal, RAeS, September, 1939.

Hazen, David C., *Some Results of the Princeton University Smoke Flow Visualization Program*, Proceedings, IAS-RAeS Fifth International Aeronautical Conference, Los Angeles, Calif., June, 1955.

Lippisch, A., *A Discussion of the Paper by David C. Hazen Presented at the Fifth International Aeronautical Conference*, Proceedings, IAS-RAeS, Los Angeles, Calif., June, 1955.

IAS PUBLICATIONS AVAILABLE

No. FF-17 ***Atomic Reactors*** (a symposium)
Member Price **$1.25** *Nonmember Price* **$1.75**

No. FF-16 ***Inertial Guidance*** by W. Wrigley, R. B. Woodbury, and J. Hovorka (This is a revised version of IAS Preprint No. 698, presented at the IAS 25th Annual Meeting, now out of print.)
Member Price **$0.75** *Nonmember Price* **$1.25**

No. FF-15 ***Some Concepts and Problem Areas in Aircraft Flutter*** by I. E. Garrick, The 1957 Minta Martin Aeronautical Lecture
Member Price **$0.50** *Nonmember Price* **$1.00**

A study of the use of arresting barriers for safe operations on shorter runways.

Aircraft Overrun Barriers

Major John E. Snow, USAF
Wright Air Development Center, ARDC

THE AIRCRAFT overrun barrier is an emergency aircraft arresting gear used for the arrestment of aircraft that overshoot the runway during the landing roll or after a refused take-off.

The primary purpose of the barrier is the saving of crew lives and public property. The secondary purpose is the improvement of operational capabilities and a reduction in runway length requirements.

The equipment consists of a component which engages the overrunning aircraft and an energy absorber (sometimes called an arresting engine) linked to the engaging component. The engaging component may be in the form of a nylon net or a steel cable and nylon net combination. The energy absorber may be of several types such as a linear friction brake* or fluid drag tube. Fig. 1 shows a typical barrier system, and Fig. 2 is a photograph showing the nylon engaging components and the anchor chain energy-absorbing means.

At this point, it appears necessary to differentiate arresting gear from barriers. Arresting gear is the equipment used in performing the normal arrested landing function each time the aircraft is landed. An example of this is the arrested landing performed aboard aircraft carriers each time the aircraft is landed on the flight deck. Barriers perform their function later in the landing phase and only when the aircraft has failed to engage the normal arresting gear. The barrier, therefore, is the backup system or emergency system preventing overrun of the aircraft. The Air Force does not employ arresting gear because the runway is of sufficient length so that aircraft brakes and deceleration parachutes normally stop the aircraft. In the event of a failure of these systems, a landing far down the runway, or a refused take-off—any of which could result in overrunning—the barrier installed at the end of the runway performs its emergency function of stopping the aircraft. The energy-absorbing principles and equipment used on arresting gear and barriers are either identical or very similar.

Air Force barriers differ from Navy barriers used on aircraft carriers. The length of runout or arresting distance for Air Force barriers is approximately four times that of aircraft carrier barriers. Another difference is that Air Force barriers predominantly utilize linear energy absorbers with little or no reeving or mechanical advantage between the engaging component and the energy absorber. There is a twofold reason for these differences. The *first* is the necessity for the reduction in deceleration forces applied to the aircraft. Air Force aircraft do not possess the structural integrity to withstand large decelerations that occur in the short runout arrested landings. Additional structural integrity beyond that existing in land-based airframes is not required because land-based aircraft are not forced to operate from limited spaces such as on a carrier. Therefore, without this structural advantage, the arresting

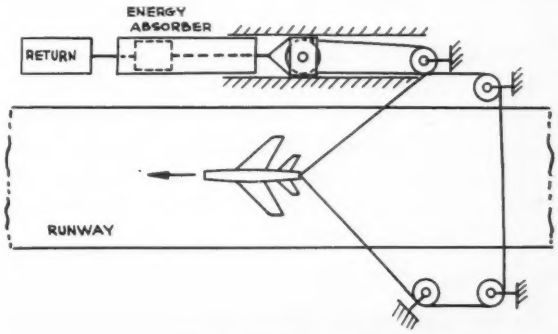


FIG. 1. Typical system.

FIG. 2.

* A braking device wherein the break force is produced over a linear distance, such as a shoe break on a rail.

Major Snow is Chief, Catapult & Arresting Gear Section, at the Aeronautical Accessories Laboratory.

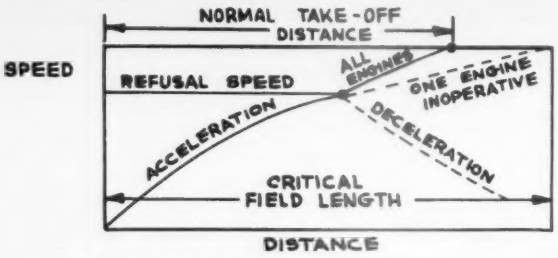


FIG. 3. A definition of critical field length.

distance for Air Force aircraft must exceed that of Naval aircraft. The *second* difference is that the Air Force predominantly uses linear energy absorbers having a minimum of reeving and normally less moving mass. Large moving masses and high engaging speeds cause large inertia loads to be imposed on the aircraft. Land-based operations lose the relative wind advantage found on carriers. This results in higher relative velocities between the landing aircraft and the landing surface. These higher landing and take-off velocities introduce high engaging velocities at the barrier. If engaging velocities increase, so do the energy-absorber component part accelerations increase when the energy absorber is brought up to speed during the engagement. These acceleration or inertia forces should be kept to a minimum.

ANALYSIS OF JET OPERATIONS

The performance characteristics of jet aircraft have resulted in high landing and take-off speeds requiring the use of long runways. In addition, we have other factors which cause an increase in runway length: critical field length, refusal speed, all weather operations, and malfunctions.

Critical Field Length

The critical field length is the length of runway required for an airplane to accelerate to a particular speed with all engines operating and at that particular speed be able to either continue take-off with one engine inoperative or stop in the remaining distance. Fig. 3 illustrates this point.

Refusal Speed

Refusal speed is the highest speed to which the airplane can be accelerated and still be stopped on the remaining runway. When the rules for critical field length are observed, a take-off with an inoperative engine will always be possible if engine failure occurs at or above the refusal speed. In the case where actual runway length is equal to critical field length, a take-off with an inoperative engine may be made in the same distance required to stop from refusal speed. In the event that refusal speed is higher than take-off speed, the take-off speed is considered to be refusal speed. Therefore, refusal speed is that speed reached at a point along the runway during the take-off run where the pilot knows he can successfully continue take-off in the event of a power failure of one of the jet engines. In the event of power failure before the refusal speed point, there is sufficient runway remaining for the pilot to refuse take-off and stop. In operating single-engine jet aircraft, refusal speed is that same speed reached at a point along the runway where the pilot knows he can successfully complete the take-off in the remaining distance or refuse take-off and still be able to stop on the runway. However, for single-engine jet aircraft once the refusal speed point is passed and a subsequent power failure develops, overrunning the runway is inevitable.

The relatively low acceleration of jet aircraft as compared to propeller-driven aircraft has moved this refusal speed point further down the runway. Military operations may be conducted in some remote corner of the globe where runway length is critical. In cases of this nature, the refusal speed point may be very near the end of the runway where the remaining runway length is insufficient to stop the aircraft during a refused take-off. In the past, the emergency procedure used by the pilot had been the retraction of the landing gear and the skidding to a stop. Safe operations on shorter fields cannot be achieved until these factors are either controlled or alleviated.

The above factors dictate a difference in barrier design and usage. There is no doubt that the single-engine jet fighter needs barrier equipment capable of accepting the aircraft at or above stall speed and at the take-off gross weight in case engine failure occurs just before the end of the runway. This in effect says that barrier equipment for jet fighters can be installed just beyond the take-off point, and, if reliable equipment is available, the maximum refusal speed could be increased right up to the take-off speed; runway length would not be required for aircraft deceleration because the barrier would provide this deceleration. Thus the refusal distance and take-off distance can be made to nearly coincide.

The multijet-engine airplane requires a minimum runway length called the critical runway length, therefore, barrier equipment would be installed beyond the critical runway length. With this in mind, consider the question, "Under what conditions would a multijet-engine aircraft approach or require a barrier on take-off?" Some of these conditions are as follows:

(1) On refused take-off prior to or at maximum refusal speed with the subsequent failures of the brake chute or brakes. This condition could cause the aircraft stopping distance to exceed the critical runway length and require an emergency barrier.

(2) Indecision on the part of the pilot just beyond the maximum refusal speed point resulting in a late attempt to effect refused take-off. This could result in overshooting the critical runway length and would require a barrier.

(3) Say that beyond the maximum refusal speed point a safe engine inoperative take-off is being executed and

major difficulties develop (such as fire warning lights coming on or another engine failure). A refused take-off must be attempted, and overshooting the runway is inevitable.

Thus from the above it appears that the following conclusions can be made regarding barrier engaging speeds and weights. Item (1) is possible but probably will occur for only a small percentage of the take-offs, and the barrier engaging speed will be much less than refused take-off speed. The aircraft weight would equal the take-off weight. Item (2) would result in basically the same condition, only at slightly higher speed. Item (3) is possible, but statistically the probability is somewhat remote. Therefore, a multijet-engine pilot refusing take-off in accordance with established operating procedure would always engage a barrier at take-off gross weight. The speed at barrier engagement in all probability would be far below maximum refusal speed. It is concluded from this analysis that the design criteria for multijet-engine aircraft barriers should be take-off gross weight at approximately 100 knots maximum engaging speed. It is also concluded that multijet-engine aircraft barrier equipment will not shorten runway length requirements because the maximum refusal speed point, take-off distance, and critical runway length cannot be made to coincide as in the case with single-engine jet fighters. The barrier equipment then offers improved safety of operation but no reduction in runway length.

All Weather Operations

The operation of high-performance jet aircraft under all weather conditions has an effect on the runway length required. Under instrument flight conditions, the precision control of airspeed and glide path altitude required of the pilot during an instrument approach must be within approximately 10 knots and plus or minus 25 ft. Positive deviations from these limits usually result in the occurrence of the landing touchdown farther down the runway. Until the day of 100 per cent automatic approaches, we must plan to have additional runway length to cope with the overshooting problem. Other weather conditions such as ice, snow, and rain decrease braking action, resulting in longer landing rolls.

The landing operations with multijet-engine aircraft will probably produce more substantial justification for barrier use than the take-off operation. During approach and landing, the following factors indicate a need for barrier equipment:

(1) Instrument approaches and other approaches resulting in a landing well down the runway.

(2) Committed landings due to low fuel reserves making a go-around impossible. A long hot landing under these conditions could result in overshooting.

(3) Wet or icy runways providing poor braking action.

(4) Equipment failure or battle damage resulting in no brakes or brake chute.

Combat Damage and Malfunctions

Landing combat-damaged jets or jet aircraft having inoperative brakes or flaps requires the use of long runways. The absence of conventional propeller drag is particularly noticeable, and this, coupled with the residual thrust of jet engines, again requires longer runways.

The reduction in runway length and the capability to operate from shorter runways can be more safely tolerated by utilizing aircraft overrun barriers. Overshooting the runway on landing roll due to malfunctioning equipment or poor weather conditions can be handled by barrier equipment in lieu of runway extensions.

Technical Problems in Barrier Design

We have seen from the brief analysis of jet operations that it is desirable to have barrier equipment capable of the following:

(1) Arresting aircraft at near take-off speeds and take-off weights.

(2) Handling of a variety of aircraft with varying energy conditions.

(3) Ease of maintenance and installation. In order to achieve the above features, some of the technical problems that confront the barrier designer should be considered.

Energy Considerations

The energy to be absorbed from some of the present-day jet fighters is approximately 60 million ft.lbs. for the take-off conditions and approximately 110 million ft.lbs. for bomber aircraft. This energy must be absorbed at a rate during the arrestment which is equivalent to absorbing approximately 25,000 hp. Therefore, just imagine turning "on" a 25,000-hp. energy absorber and 7 sec. later turning it "off." In this brief period of time the function must be completed.

Engagement Speeds

The engaging speeds on present-day barriers have been as high as 160 knots. The current design requirement is 180 knots. Thus consider the energy absorber standing at rest awaiting engagement which almost instantaneously after engagement must accelerate up to the speed of the aircraft.

The total mass of energy absorber is somewhat proportional to its capacity. However, the high acceleration - large mass combinations must be avoided. The design of the energy absorber must be achieved with a minimum of moving mass. This is necessary to avoid the transmission of excessive forces to the aircraft through the engaging component when the arresting engine is accelerated and brought up to speed.

Transients

The problem of controlling or limiting transients is exceedingly complex. The high speeds and high forces under which the equipment must operate would, under

steady-state conditions, be an ordinary design problem, but, under the varying conditions present during an arrestment, the transient behavior is a difficult design consideration. The dynamics of moving cables and other impulse conditions under which the equipment must operate are all part of the design problem. This in itself is an ordinary statement familiar to any designer, but, when we consider the extent of our present-day knowledge of arresting equipment transients, it no longer becomes a familiar design statement.

Aircraft Structural Limitations

The decelerating forces applied to the airframe must be less than the structural limitations of the aircraft. Air Force aircraft do not possess structural "beef-up" for arrested landings. High *g* decelerations can be avoided because we have the space for runout during the arrestment. The energy absorber must be capable of applying a controlled deceleration force and must be controlled to stay within the airframe structural limitations. Control in this instance also includes the design consideration for the avoidance of large accelerating loads in the moving mass of the energy absorber.

Variety of Aircraft Configurations

The variety of aircraft configurations that are to be engaged and subsequently arrested requires the use of a universal engaging component so that the timing of the arresting cable engagement is adaptable to the various aircraft. One airport may be operating as many as six different aircraft configurations. The installation of an arresting hook would introduce a point of similarity. However, remember that a barrier is an emergency arresting device, and the weight that would be added to the airframe by the arresting hook must be justified by considering it as safety equipment similar to ejection seats. When the day of Air Force operational arrestment arrives using arresting hooks, we will have some alleviation from the problem. The advantage of having features designed into the airframe is obvious, but under emergency and intermittent arrestment the justification for airframe modification is hard to formulate.

Range of Engaging Energy Conditions

The present range of energy conditions for fighter aircraft varies from less than a million foot pounds to 60 million. The energy absorber therefore must be capable of adjustment. If, for example, the energy absorber is set to absorb 60 million ft.lbs. and a lightweight aircraft should engage the system, destructive loads would be applied to the airframe. It is therefore necessary that either an automatic control sensing deceleration in *g* be incorporated in the energy absorber or that the control tower operator set the control for the type of aircraft operating on the runway.

Ease of Maintenance

The complete system must be capable of operating under worldwide climatic conditions. Ease of maintenance implies such terms as accessibility, simplicity consistent with design requirements, logistical soundness in regard to spares and transportation, and, finally, stability of operation without constant adjustment. A few examples of the stability problem will be given. The use of nylon nets as engaging components offers a good solution to the problem under controlled conditions. A nylon net, however, when exposed to the ultraviolet rays of the sun such as we have in desert operations, will undergo a marked decrease in ultimate strength. This would require periodic inspection and replacement.

Another example of the stability problem is the friction brake linings. The varying moisture conditions of various climates could have an effect on friction coefficients of the energy absorbers with a resultant change in decelerating forces. These stability problems fortunately have solutions.

Conclusion

The deceleration of aircraft is by no means new, but like many things it took a change in events to magnify the problem. In this case, it was the Korean conflict, the first jet war in history. The operation of high-performance jet aircraft from hastily prepared short runways caused a substantial number of aircraft to overshoot the runway. This resulted in an irreplaceable loss of lives and valuable combat equipment. To overcome this loss, the aircraft overrun barrier was developed. The future of the arresting barrier appears promising as an aid in improving aviation safety.

The future will produce aircraft with speeds and weights exceeding those of the present, and the philosophy of barrier usage will continue to offer its support to the overall problem of aircraft deceleration. The barrier system that will go into service should be a single configuration capable of arresting a variety of aircraft.

Change of Address

Since the Post Office Department does not as a rule forward magazines to forwarding addresses, it is important that the Institute be notified of changes in address 30 days in advance of publishing date to ensure receipt of every issue of the *Journal and Review*.

Notices should be printed legibly and sent directly to the Institute of the Aeronautical Sciences, Inc., 2 East 64th Street, New York 21, N.Y.

Improved methods of sensing the machine's performance, interpreting this intelligence, and effecting required control become basic problems as the machine's performance capability advances rapidly.

The Weapons System Approach to Air Data Computing

H. F. Creel
McDonnell Aircraft Corporation

THE WEAPONS SYSTEM of today bears little resemblance to the weapons systems of only a decade ago. There is, however, a basic similarity—both are composed of a machine and a crew to operate it. Need of improved weapons systems has dictated exhaustive programs of research and development to improve the performance capabilities of the machine and intensive training of the crew to effect optimum control of the machine.

The rapid development of the airframe, power plant, radar and electronics, and armament has resulted in spectacular advances in the machine's performance capability. Man, however, has remained relatively unchanged in his capability. As the performance capability of the machine increased, improved methods of sensing the machine's performance, interpreting this intelligence, and effecting required control became basic problems. The response had to be quicker and the resolution of the control parameters better. The machine has grown less "forgiving" in almost every aspect. There is little room for error, due either to pilot judgment or the quality and timeliness of his required information. It behooves us, therefore, to present the necessary information in such a manner as to be directly usable by the pilot, to tighten the servo loop, and hence improve the effectiveness of the weapons system.

A review of what this means in terms of the machine would reveal a rapid trend toward such devices as automatic engine control, autopilots, automatic armament control systems, navigation computers, stability augmentation systems, stall warning systems, and optimum cruise computers, to mention a few. Broadly speaking, these subsystems fall into four major categories—namely, armament control, flight control, navigation, and power-plant control. Each of these fields, and even subsystems within a given field, contains so many specialized problems that there has been a tendency to develop in each its own independent field of specialization with each subsystem solving all of its own problems independently. To those managing the development of the complete weapon system, this practice is appalling from the standpoint of weight, space, complexity, and expense.

Many of the computations required by one subsystem are common to the needs of other subsystems. Intuitively one may suggest that measurements and basic computations of the medium of flight (air) would be required by most subsystems. Hence, an air data system serves a host of other systems and is unique in the respect that it plays a part in every major subsystem making up the weapons system. The air data system which will be described is one of the many programs undertaken to develop a well integrated weapons system with a minimum of redundancy and an increase in performance and reliability as permitted by the state-of-the-art.

The complexity of air data measurement and computing has increased sharply with the extended flight envelope of today's aircraft. It may be well to review some of the associated problems and possible methods of solution.

While stretching the performance envelope, we have demanded a higher degree of accuracy throughout this envelope. This has forced the development of new sensing and computing techniques and the development of methods to correct errors inherent in the air mass sensing pickups.

It is interesting to note the changes in range required of the measuring devices. In going from Mach 1 to Mach 2, the pressure ratio is increased by a factor of 3:1. In going from Mach 2 to Mach 3, we double the pressure ratio again. To measure pressure altitude from sea level to 50,000 ft., the sensing device must sense maximum and minimum pressures in the ratio of approximately 9:1. To measure pressure altitude at 70,000 ft., the device must sense maximum and minimum pressures in the ratio of approximately 23:1. Obviously, resolution becomes a severe problem.

In moving to meet the problems created by extension of the aircraft flight envelope, it is imperative that

This paper was presented at the U.S. Navy Bureau of Aeronautics Symposium on Air Data, Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y., September 24–26, 1957.

Mr. Creel is Chief Airborne Equipment Systems Engineer.

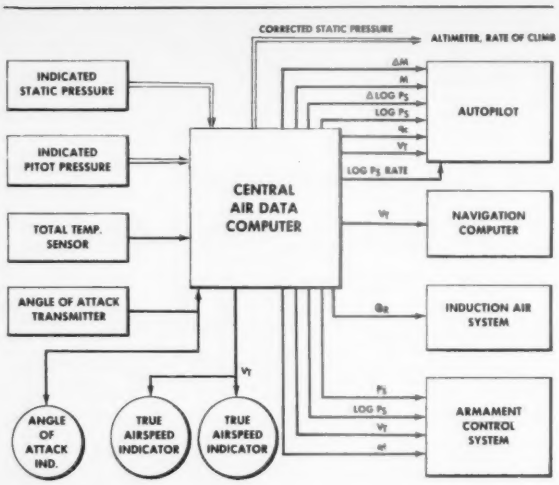


FIG. 1.

the maximum effort be expended toward refinement of each and every area of the weapons system involved in air data computation. Better transducing equipment alone is not enough. The air mass sensing techniques, particularly those related to static pressure sensing, must be improved before the break-through to accuracies which are currently being hoped for and which will ultimately be required can be realized. Herein lies the advantage of weapons system management. To effect the successful development of a central air data computation system, responsibility for the integration of the air data sensing sections, the data computing sections, and the air data using sections should logically reside within the same organization.

In the specification of the centralized air data computer for our latest series of weapons systems, we have arrived at several general requirements.

Electrical Analog Outputs

The furnishing of all computed analog parameters which are functions of air data to all subsystems requiring such inputs is one general requirement.

Fig. 1 shows a functional block diagram of a typical central air data computing system. Many of the outputs represented by single lines on this chart are required in multiple form. For example, the subsystems for use in conjunction with a computer now under development by McDonnell require the following multiplicity of electrical outputs:

Corrected static pressure	2
Log static pressure	5
Log static pressure rate	1
Incremental static pressure	1
Mach Number	3
Incremental Mach Number	1
True airspeed	5
Angle of attack	3
Impact pressure	3
Variable ramp angle	2
Total Outputs	26

Since simultaneous development of using subsystems is generally the rule rather than the exception, it is imperative that maximum flexibility be recognized as a design requirement at the outset of a computer development program. Every effort must be made in designing the mechanical build-up configuration to provide for future additional outputs of existing air data parameters. Furthermore, it is highly desirable to provide sufficient access to the existing output devices to permit function reshaping if necessary.

Static Pressure Compensation

Compensation for static pressure defect in pneumatic form for bellows-operated primary flight instruments is another area of importance.

As the development program was entered, it became evident that two fundamental ground rules had already been established:

(1) Pneumatically operated primary flight instruments would likely be with us during the time span of the system's usefulness. I will discuss this more fully later on.

(2) No pressure sensing techniques were available which would justifiably preclude artificial pressure compensating devices and at the same time maintain the stringent accuracy requirements imposed by pneumatic instrumentation.

Since accurate and repeatable static pressure measurement represents one of the most formidable obstacles on the path to optimum air data computation, it might be appropriate at this point to discuss the major problems involved and the compromises necessary to effect a workable solution.

Fig. 2 illustrates the characteristics of four static pressure sensing systems employed on the same type aircraft.

The system shown on Curve 1, that most commonly used today, consists of a pair of flush ports located on opposite sides of the aircraft. On subsonic aircraft, this type of installation is marginal. On supersonic aircraft, it is almost without exception unacceptable. The flush static source is also generally influenced by

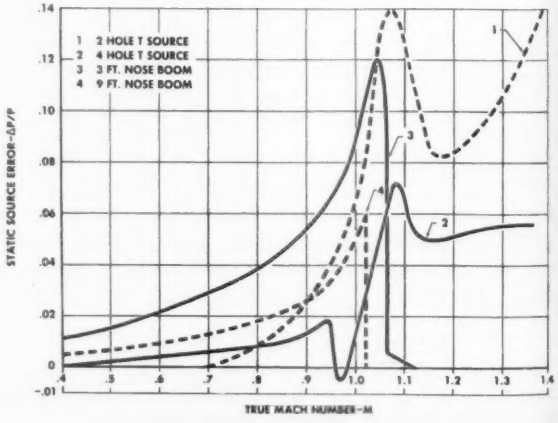


FIG. 2. Errors in static sources.

changes in airplane configuration, such as expenditure of external stores and transition from clean to landing configuration. Rigorous control must be exercised to preserve the integrity of the contour in areas surrounding the ports in order to prevent changes in calibration.

Significant improvements can be made to the flush static system, as illustrated by Curve 2, by utilizing two sets of ports. In this case, one set of the ports is located in a pressure field having a positive pressure coefficient $\Delta P/P$ and the other set in a pressure field having a negative pressure coefficient. By carefully choosing the line lengths between the ports and by selecting the optimum location in the tubing network for the sensing line, advantage can be taken of the cross flow between the sets of ports to effectively cancel out much of the defect measured by either set of ports. The major disadvantage of this system is the extensive flight test calibration program required to develop the system, plus the problem inherent in any flush static port system of assuring repeatable results.

The third system, shown on Curve 3, is increasing in popularity. This is the nose boom mounted pitot-static probe. This system has several advantages—namely, that the static source should have excellent repeatability characteristics since it is mounted in a precision built shape which is isolated from the relatively nonuniform afterbody; and that supersonic pressure measuring after the bow wave has passed aft of the static ports is essentially free of error.

The major disadvantages of the nose boom are:

(a) The subsonic defect is sizable unless the boom length is very long.

(b) The magnitude and, particularly, the slope of the error in terms of $\Delta P/P$ in the transonic region is so great that effective compensation cannot be accomplished.

(c) In the case where nose mounted radar is employed, a sizable decrease in radar transmissibility, with the associated decrease in target detection range, may be expected.

(d) In the case of carrier based aircraft, a severe problem in handling could be expected.

Some qualifications must be attached to the above statements, however. Due to the excellent repeatability characteristics of the nose boom, effective defect compensation can be accomplished in the subsonic range by either pneumatic, electrical, or aerodynamic means. Essentially all flying in the transonic region is under short term transient conditions and we may be able to neglect the inherent deficiencies of the nose boom source in this region. If we can, through compensating techniques, develop a short enough nose boom mounted source, which does not mask out an area greater than 2 in. in diameter including the structural attachment, the effect on radar performance may be tolerable.

Accuracy and Response

The need for greater accuracy takes on several forms but can be placed under two general categories—namely, (1) increased flying safety, and (2) increased kill probability (P_k).

Under increased flying safety, probably the most stringent single requirement is the accurate measurement of altitude. This requirement has been emphasized in recent years by the vast increase in aircraft density throughout the airways which has tended to reduce the assigned vertical separation between aircraft, especially in landing patterns, to marginal limits when taking into account the inaccuracy of present altitude measuring systems.

Under increased P_k, our first thought is that, with the advent of guided weapons, we can relax our requirements for furnishing accurate information for the computation of jump angle and other preguidance parameters as opposed to the stringent requirement for these quantities with unguided rockets. This premise is correct provided that we are willing to partially nullify the increased P_k realized by going to the guided weapon. This is seldom the case.

Another case involves operation of the interceptor in a data link environment where command information is presented in the absolute sense (such as command altitude and command true air speed). Then, even though the command information is precise, the interceptor may suffer a sizable degradation in target detection probability simply because of its inability to accurately assume the altitude and velocity directed.

Other factors often overlooked which affect both flying safety and P_k are the measurement of quantities which determined aircraft flight restrictions. Since the warning device or control triggered by these sensed parameters must be set on the safe side of the tolerance limit, often a significant part of the flight envelope is lost simply because of the inaccuracy of measuring a flight parameter.

Having admitted and agreed to the need for increased accuracy caused by expanded flight envelopes, we should pursue with equal diligence the oftentimes overlooked corollary. In all cases where a reduction in accuracy requirements seems warranted, this license should be granted to the equipment manufacturer. By nature, we have come to expect that each and every progressive step be bigger and better than the preceding one. This philosophy if unchecked can make an exacting and difficult design job impossible. Advantage should be taken of obvious compromises. An example of implementation of such thinking is in regard to air data parameter outputs used exclusively for gain changing automatic flight control signals. In many cases, it can be shown that these signals do not have exacting accuracy requirements. Other examples could be cited. How often are we guilty of specifying accuracies of $\pm$ 1 per cent simply because the industry has already demonstrated attainable accuracies of $\pm 1^1/_4$ per cent? In defining modern day complex air data computers, we cannot afford this luxury.

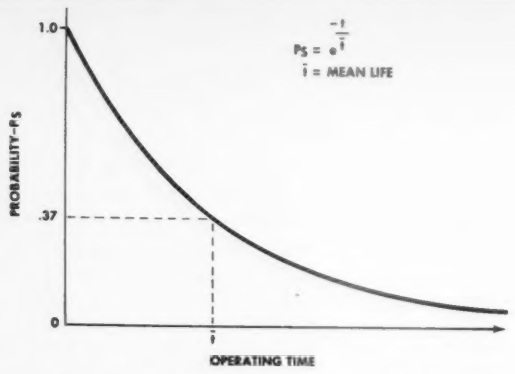


FIG. 3. Probability of success vs. operating time.

Reliability

It was realized that the centralized air data computer, in order to play a successful part in the weapons system, must be a reliable device. It was decided that if desired reliability were to be attained, it would be necessary to make reliability a well defined contract requirement instead of merely a much-sought-after objective. It was also necessary to devise a reliability implementation program which included reliability and failure analyses and component testing so that the reliability could be predicted and certain components improved where necessary. It was apparent that specifying a requirement without a demonstration to show that it was attained was not enough, so a reliability test simulating the actual operating conditions was included.

Reliability was specified in terms of the mean time to failure (mean life) and a failure was defined as any malfunction which caused the performance to drift outside specification limits. As a result, the mean life specified is a measure of the frequency of all failures, from the degrading (nuisance and other types which may not fail the complete function of the system) to the catastrophic type (which may fail the function of the system). A comprehensive failure analysis is being performed evaluating various types of failures and determining their potential effect upon other related systems and the airplane mission. In mathematical terms, the mean life is related to the random failure (exponential) curve shown in Fig. 3 and may also be expressed as a probability of success corresponding to some operational time.

It is extremely expensive to prove precisely that a system has some specified reliability. It is believed possible and practical to obtain statistical evidence, within reasonable confidence limits, that the required mean life has been demonstrated. To demonstrate this, several systems selected at random will be tested under simulated operating conditions for a minimum of 1000 hours each. While operating, continuous changes in static pressure, total head pressure, total temperature, and angle of attack will be imposed on the equipment and outputs recorded. The total test time accumulated on these systems divided by the total number of failures occurring during the test time must equal or exceed the required mean life.

CONCLUSIONS

By concentrating our design efforts and testing on the centralized air data computer as opposed to a separate air data source for each subsystem, we can accomplish a sophistication in design not possible otherwise. In doing so, the following advantages accrue: a higher degree of accuracy, greater reliability, less weight and space, better response due to the deletion of many pneumatic lines and bellows assemblies, and greater flexibility through the use of servoed shaft outputs with which we can drive various types of signal generators.

Additional advantages may be gained by utilizing the centralized air data computer in conjunction with servoed instrument displays. It is possible to provide instruments with increased accuracy, as well as to change the displays to incorporate such subtle features as "quickening" and "unburdening," thus helping the pilot to tighten the servo loop and increase weapons system effectiveness.

A "quickened" display is one that presents a prediction of the imminent response of the aircraft, thus providing the pilot with an immediate indication of the appropriateness of his control inputs. "Quickening" may also be employed to compensate for time lags resulting from the use of slow sensing devices or pressure lag in the pitot-static system. In high performance aircraft where precision control is required, it would appear that this technique is becoming a necessity for displays of absolute aircraft performance, such as altitude, air speed, or Mach displays, and particularly vertical speed displays.

The "unburdening" technique can be employed where command information exists such as that originating from a data link or perhaps from an optimum cruise computer. In this case, the information can be presented so that the pilot acts as a simple amplifier to null out visual error signals presented on his displays.

The chief argument against the use of servoed primary flight instruments has been the question of reliability. This cannot be idly discarded for the apparent servo loop of any weapons system must be a reliable one regardless of how we close the control loop, be it remotely, automatically, or from the pilot's cockpit. It is believed that the argument often presented that pilots will not accept servoed primary flight information is an overworked one and not really justified. An example of this was the change a few years ago from the mechanically coupled gyro horizon display to the remote indicating all attitude display system. This is a relatively complex system containing a remote gyro with gimbal position transmitters, servo amplifiers, and a servoed attitude display. Yet, even though this is considered by all-weather pilots as their most vital flight instrument, pilot acceptance was immediate due to the

(*Continued on page 50*)

Research and Development Planning in the USAF

Lt. Col. Carlo R. Tosti
Hq. Air Research and Development Command

The objective of the body of planning documents within the USAF is to channel thinking toward anticipated future objectives and to provide a pattern for the management of a development program once initiated.

THE SCIENCE OF AVIATION has progressed tremendously since the first powered flight by the Wright Brothers a little over a half century ago.

This increase in performance has been matched, if not surpassed, by increases in complexity of design, production, investment of critical raw materials, and scientific and technical manpower.

Under the pressure of limited resources of time, raw materials, and skilled and trained manpower, on the one side, and the pressure of a demonstrated Soviet technical capability and interest on the other, we are being squeezed hard.

It becomes increasingly important, therefore, to plan carefully—both to conserve resources and to shorten the development time cycle. Planning for research and development is broadly similar to planning for a military operation except that a much longer time period is involved. This important task of planning must be done early, and it must be done at all levels of operation.

At the ARDC level, this planning extends across the air power development spectrum (Fig. 1) in the areas of research, technical development, and weapon systems development.

In general, the objective of this planning is to obtain the most advanced state-of-the-art possible for a decade or more in the future—an advanced state-of-the-art which will assure the design and development of qualitatively superior weapon systems for future time periods. Three types of planning documents are prepared at the Hq. ARDC level to accomplish this purpose. These are the Research Planning Objective (RPO), the Technical Program Planning Document (TPPD), and the System Requirement (SR).

While these documents were originally visualized as internal planning documents to harness and channel the thinking and efforts of our widespread research and development activities toward common scientific and technical objectives, we have found them to be valuable

FIG. 1.

to the universities and industrial companies which support our research and development activity. In fact, in our program to orient industry to our anticipated needs, we have distributed TPPDs widely. Also, a large number of companies have visited us in Baltimore for individual discussion periods on our SRs.

At the present time, about 625 companies are voluntarily engaged in our TPPD program, and 186 industry study groups are engaged in the SR program. When our Research Planning Objectives are prepared, we intend to distribute them also to the scientific community.

Obviously, the contribution of research and development studies by the participating companies represents an important adjunct to the USAF program. Quite as important, however, is the fact that these documents alert science and industry to the needs of the future. In creating a better understanding of anticipated needs and development trends, they help to develop the capability of industry to satisfy these needs more quickly and effectively when called upon to do so in the future. In short, they play an important part in fostering the USAF - industry-science team concept in building air power.

Furthermore, these planning documents lay the foundation of advanced thinking and point to an advanced state-of-the-art for the design of future operational weapon systems. Thus, they produce important inputs for the planning, the determination, and the validation of future weapon system requirements at Hq. USAF.

This article has been updated and condensed by the author from the paper of the same title presented at the Technical Requirements Planning Session, IAS National Summer Meeting, June 17–20, 1957, in Los Angeles, Calif.

The author is Director of Information Services, Headquarters, ARDC, USAF, Baltimore, Md.

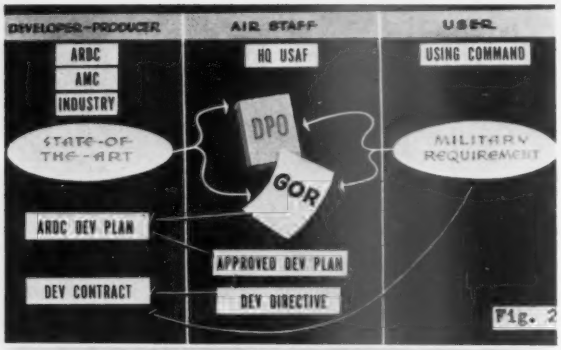


FIG. 2 (*Top*). Weapon system planning cycle. FIG. 3 (*Bottom*).

Let us now discuss the general plan for the establishment of a weapon system requirement in the Air Force. I say general plan since, although we prescribe an ideal order in our planning cycle, the exigencies of any particular time or problem may dictate variations from the ideal. In general, the weapon system planning cycle follows the pattern shown in Fig. 2.

Three major breakdowns of activity are involved—planning and requirement validation at the Hq. USAF level; statement of military needs by the using command, such as the Strategic Air Command, the Tactical Air Command, or the Air Defense Command; and the design, development, and production of weapon systems by the ARDC, the AMC, and industry.

The cycle for the development of future weapon systems starts with development planning. This planning results in certain goals which may be referred to as Development Planning Objectives (shown as DPO in Fig 2). From such planning comes the General Operational Requirement (GOR) for a specific weapon system (both of these efforts benefit from inputs on state-of-the-art from the developer-producer side and on military needs from the using command side). The GOR is sent to the ARDC where a development plan is formulated. The development plan is then sent to Hq. USAF for approval. When approved, a development directive is sent to ARDC directing the initiation of the development program with industry. During the development cycle, ARDC works closely across the board with all the interested commands to ensure that the product will do the job for which it is required. This is the general plan of operation.

Let us now discuss each of the planning phases in greater detail (see Fig. 3). The development planning phase is directed toward establishing broad qualitative guidance for the development of systems and techniques which will most effectively accomplish Air Force operational missions under probable future war conditions.

Until recently, these objectives were published in formal documents known as Development Planning Objectives (DPOs). Because of the difficulty in keeping these documents updated, they have been discontinued as complete mission DPOs. Instead, studies are conducted to produce the necessary guidance for the development of specific future weapon systems.

Development planning studies result from an analysis of the offensive and defensive capability, the industrial capacity, and the economic factors influencing the military potential of a nation, or nations, with which the United States may, in the future, be engaged in military conflict. The geographic location, military alliances with other nations, the relationship and orientation of land-water areas, the terrain and the climatic factors pertaining to the potential enemy country, and the racial and social characteristics of the people provide essential ingredients of the study.

Although the Director of Development Planning, Hq. USAF, is responsible for preparing development planning studies, active assistance in their preparation is provided by all parts of the air staff and the major air commands. The ARDC makes an important contribution through participation in this team effort by providing the state-of-the-art inputs. Furthermore, assistance is sought from the Department of Defense, Army, Navy, intelligence agencies, and other organizations in the preparation of the broad planning documents.

From the development planning study, a GOR is evolved. A GOR provides the criteria for development planning of a specific weapon system or support system (Fig. 4).

General Operational Requirements are statements of

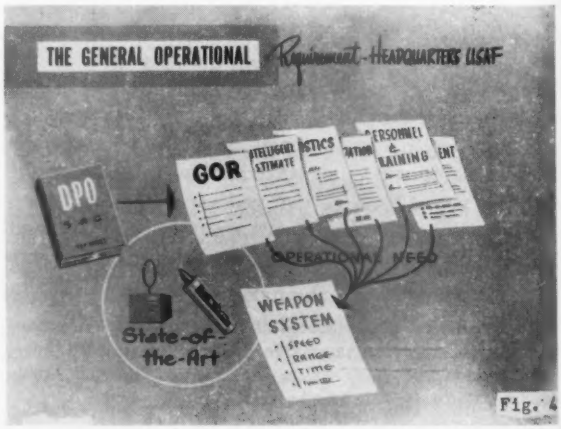


FIG. 4.

FIG. 5.

operational need arising from a prescribed operational objective. They are in consonance with the applicable development planning objective and are written in terms of a specific time period under the direction of the Director of Requirements, Hq. USAF. They include intelligence, combat, logistical, organizational, personnel and training, and environmental factors, as appropriate. These factors combine with the realistic appraisals of the state-of-the-art to identify the scope or range of capability within which the requirement will be established.

General Operational Requirements emphasize the operational needs and not the technical approaches by which these needs can be satisfied. They may, however, include suggested methods of meeting the operational need. They do not include the detailed qualitative operational characteristics of components of the required system.

The requirements which they establish may be met by the purchase of commercial items, by the procurement of Army or Navy developed items, by the modification of existing items, by the additional production of existing items, or by the development of new items.

Upon publication of a GOR for a particular weapon system, the Assistant for Development Programing, Hq. USAF, directs the ARDC to prepare a development plan (Fig. 5) designed to satisfy the provisions of the GOR.

The development plan proposes a solution to the problem outlined in the GOR. It includes a technical analysis of the requirement indicating all of the technical areas in which development is required, a time-phased schedule for the work, and realistic estimate of the direct resources required.

The development plan will be evolved from existing or, if required, new design studies including a complete review of the state of all applicable existing and projected component developments and an estimate of the probable state of research and technical development within the time period specified in the GOR. The plan will include the following:

(1) A general description of the system.

(2) The military characteristics of subsystems and major components. These state in technical terms the range or limits within which the performance capabilities of the components will lie. The probability of the proposed development providing the desired combat or support capability will be judged primarily by an evaluation of the military characteristics of the subsystems and components. This part of the development plan is, therefore, given particular attention and the military characteristics are a specifically identified major part of the development plan. Detailed specification type data are excluded.

(3) A survey of, and recommendations on, the use of related equipment in the Air Force inventory, equipment in research and development, commercial equipment, and Army and Navy equipment.

(4) The estimated time phasing of the basic vehicle and major components of the system to be developed.

(5) Proposed procedures for the award of contracts.

(6) A statement of requirements for all resources, such as personnel, facilities, funds, matériel, support equipment, and testing necessary to satisfy the requirements of the GOR.

(7) Recommendations on what items in the USAF inventory, or currently under development, can be replaced by the planned system or its components.

(8) Comments on effects of the system on maintenance, stressing reliability and cost of maintenance, organization, human factors, training, and logistics.

The preparation of the development plan is not a unilateral effort on the part of ARDC. Depending upon the complexity and the advanced nature of a proposed system, ARDC will work with industry, the operating command for which the system is required, the Air Staff, other government agencies such as the NACA and the Atomic Energy Commission and the other services in coming up with a realistic and effective development plan.

The development plan is approved at Hq. USAF and development is initiated when authority to proceed and resources are provided.

This, in short, is the system for research and development planning in the Air Force. A number of different documents and a number of different organizations are involved. Documents and the organization alone are of little value, however, if interest and enthusiasm in the planning function is lacking. Encouragingly, top management in American industry is becoming more and more aware of the importance of long range planning in the technical area. A number of major companies have set up planning groups to look to the future. This is vital not only to the future growth and survival of these organizations in a tough business but also to us as a nation whose resources must not be squandered in unproductive efforts.

Our attention to technical planning, therefore, must be continuous. The payoff from this effort will be a stronger air industry and qualitatively superior American air power.

The weight of the structural box of an aircraft wing is estimated by means of a multiple station analysis and an exponential time trend. Optimum weight is calculated from the multiple station analysis which is based on a simple beam representation of a semiwing. It was found that a high correlation exists between the ratios of optimum weight to actual weight and time.

Estimating Structural Box Weight

Lyle D. Green and Joseph Mudar
The University of Michigan

Symbols

$W_{(b+s)0}$ = optimum structural box weight
$W_{(b+s)a}$ = actual structural box weight
R_a = $W_{(b+s)0}/W_{(b+s)a}$
E = error in estimation
E_{rms} = root-mean-square error
T = time interval between January, 1944, and first flight of aircraft, measured in months

One major concern of the aircraft weight engineer is the devising of methods for estimating the weight of the structural box of an aircraft wing. Inherent in any method is determining the optimum weight and the relationship between optimum weight and actual weight.

Many approaches to the problem are found in the literature. Shanley[1] applies a multiplying factor for nonoptimum weight. This factor is a function of aircraft parameters. Hyatt[2] expresses nonoptimum weight as a function of equivalent stress.

In this method estimating structural box weight is accomplished by multiplying optimum weight by a factor, K, which is a function of time. Time is measured in months from January, 1944, to first flight date.

Since the optimum weight of the structural box is determined by a multiple station analysis, Part I of this report outlines the analysis and summarizes the assumptions made in arriving at the optimum weight. Attention is given to the type of air-load distribution used, the design conditions imposed upon each type of configuration, the function used to distribute wing weight for inertia loading, the allowables used in compression, and the effective thickness function used. Part II discusses the time function generated to estimate the structural box weight.

Relative error regression theory (the Appendix) was applied to 20 aircraft, some production models and some in design stages. The root-mean-square error was 8.88 per cent.

This paper was presented at the National Conference of the Society of Aeronautical Weight Engineers, Wichita, Kan., April 29–May 2, 1957. The work described was conducted under the sponsorship of the Weights Section, Design Branch, WADC.

Mr. Green is Associate Research Engineer, and Mr. Mudar is Research Associate, both at the Engineering Research Institute.

(I) Multiple Station Analysis

The multiple station analysis[3] determines analytically the optimum weight of the bending and shear material of an aircraft semiwing based on a simple beam representation. This section outlines the procedures used and assumptions made in determining the weight.

The Weissinger method[4] was used to determine the air-load distributions. Inertia loading due to the wing structure is distributed approximately proportional to the volume of the wing. Gross wing weights were obtained from group weight statements or were estimated by a preliminary method.[5] Actual, calculated, and estimated weight reports were used for the analysis; the latter two were used only when actual reports were not available.

Although there are many conditions considered in the design of an aircraft wing, to simplify the analysis, only a representative flight condition and landing impact condition have been considered. The internal and external stores, engines, nacelles, and landing gear were treated as concentrated loads. To express the bending moment in terms of loads in the upper and lower spar caps, an effective thickness must be determined. Through the use of certain simplifying assumptions, an approximate expression for the effective thickness was analytically derived.[6] This method consists of assuming the structural material of the wing to be divided equally between the upper and lower skin covering of the structural box. The material is assumed to be distributed spanwise as a linear function of the thickness of the airfoil sections. The distance between the centroids of the cross-sectional areas of the structural material is considered the effective thickness of the airfoil section.

The allowable in compression for stiffened panels is taken from Fig. 1 which plots the allowable in kips/sq. in. versus surface loading in kips/in.[7] The rib spacing is assumed to be 30 in., and the coefficient of fixity is assumed to be one. Provisions are made for minimum gage considerations in the analysis.

The analysis is formulated so that any one of several methods for calculating air-load distributions may be employed. It is likely that weight engineers using the

form would start directly with furnished shear and bending distributions.

(II) Exponential Time Trend

In attempting to correlate the ratios with the time of first flight it was observed that the ratios were approaching one with increasing time, therefore an exponential time function of the form $R_e = 1 - e^{-(a+bT)}$ was used to predict the ratio. This function approximates the changing state of the art in that the predicted ratio approaches unity as T approaches infinity.

Relative error regression theory was used to obtain the constants a and b. The sum of the squares of the relative error of the natural logarithm of the complement of the predicted ratios were minimized. Thus the complement was the dependent variable and the time of first flight was the independent variable in the analysis. The values obtained for a and b were -0.0739 and $+0.009375$, respectively. The mathematical development of the regression theory used is found in the Appendix.

Fig. 2 shows a plot of the ratios versus time of first flight for the 20 aircraft in the sample. The time function is drawn to show the deviations from these ratios. Fig. 3 shows a plot of E, the error in estimation of structural box material versus time of first flight for all aircraft in the sample. The greatest error is about 17 per cent and the root-mean-square error is 8.88 per cent.

Conclusions

This study has shown it possible to estimate the weight of the structural box of an airplane wing within acceptable errors. The technique employs a multiple station analysis to determine the optimum weight and an exponential curve which is a function of time to estimate the actual structural box weight. The multiple station analysis treats the aerodynamic and geometric parameters in an analytical manner for determining optimum weight, while the time function reflects the aircraft manufacturers' design practices and the changing state of the art in aircraft construction. This type of analysis is made possible, in part, from the success the weight engineers have had during the past 15 years in making designers weight conscious. The advancements made in structural design and the refinements made in manufacturing techniques have reduced non-optimum weight, hence the ratio of optimum weight to actual weight becomes larger as advanced designs come off the assembly lines. It has been the practice of the E.R.I. to separate aircraft by types in applying weight estimation techniques because greater accuracy could be attained by using a separate set of statistical constants for each group. However, for this analysis all aircraft can be estimated within an acceptable root-mean-square error by a single set of statistical constants.

Appendix

Relative error regression theory:

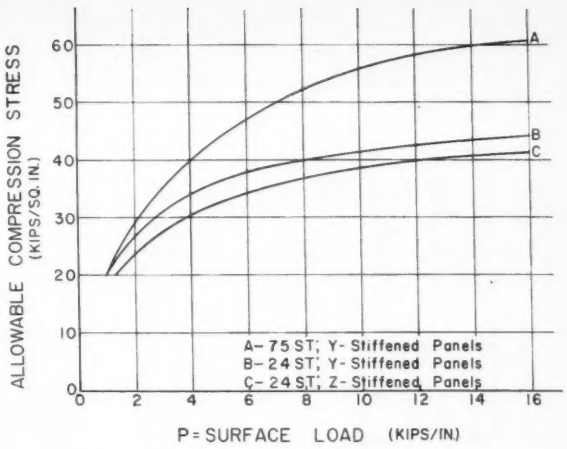

ALLOWABLE COMPRESSION STRESS (KIPS/SQ. IN.)
P = SURFACE LOAD (KIPS/IN)
A– 75 ST; Y- Stiffened Panels
B– 24 ST; Y- Stiffened Panels
C– 24 ST; Z- Stiffened Panels

Fig. 1. Design envelope curves for stiffened panels (NACA TN No. 1389).

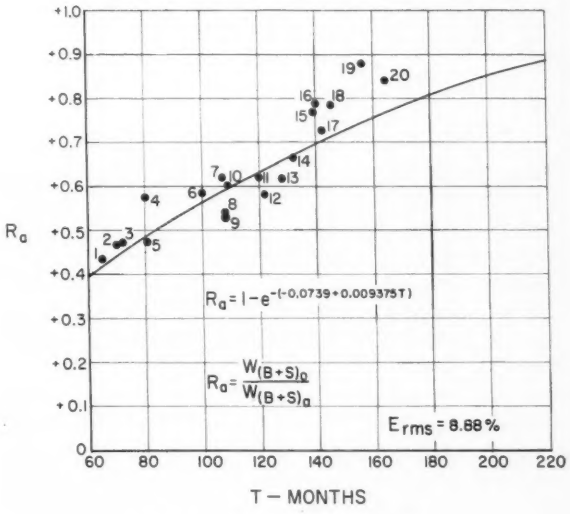


Fig. 2. Exponential time curve.

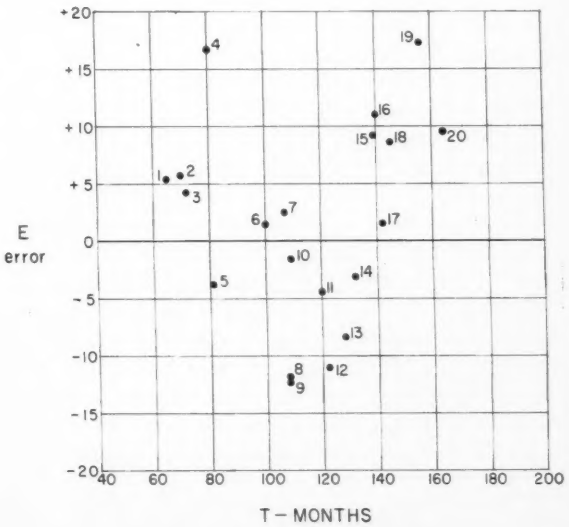


Fig. 3. Errors in estimation.

$$R_a = W_{(b+s)0}/W_{(b+s)a}$$
$$R^1_a = 1 - R_a$$
$$\ln R^1_a = \ln (1 - R_a)$$

$$R = 1 - e^{-(a+bT)}$$
$$R^1 = e^{-(a+bT)}$$
$$\ln R^1 = -(a + bT)$$

The relative error, e, in estimating $\ln R^1_a$ is

$$e_i = (\ln R^1_{a_i} - \ln R^1_i)/\ln R^1_{a_i}$$
$$e_i = (\ln R^1_{a_i} + a + bT_i)/\ln R^1_{a_i}$$

The sum of the squares of the relative errors is

$$\sum_i e_i^2 = \sum_i [(\ln R_{a_i} + a + bT_i)/\ln R^1_a]^2$$

Taking the partial derivatives of this function with respect to the constants a and b leads to a solution for the constants.

REFERENCES

[1] Shanley, F. R., *Structural Weight Analysis General Method: Wing Structures R-100*, The RAND Corporation, October 1, 1948.

[2] Hyatt, Abraham, *A Method for Estimating Wing Weights*, Journal of the Aeronautical Sciences, Vol. 21, No. 6, pp. 363-372, June, 1954.

[3] Klein, Robert, *A Station-by-Station Analysis for the Determination of Optimum Weight for the Structural Box of a Wing*, 2439-4-T, The University of Michigan, Engineering Research Institute, July, 1956.

[4] De Young, John, *Theoretical Additional Span Loading Characteristics of Wings with Arbitrary Sweep, Aspect Ratio, and Taper Ratio*, NACA TN 1491, 1947.

[5] Spath, R. M., *A Simple Wing Weight Estimation Equation*, 2063-3-J, The University of Michigan, Engineering Research Institute, May, 1954.

[6] Mudar, J., *A Method for Determining the Approximate Effective Thickness of an Aircraft Wing*, 2439-516-M, The University of Michigan, Engineering Research Institute, July 10, 1956.

[7] Dow, Norris F., and Hickman, William A., *Design Charts for Flat Compression Panels having Longitudinal Extruded Y-Section Stiffeners and Comparison with Panels having Formed Z-Section Stiffeners*, NACA TN 1389, August, 1947.

✦ ✦ ✦

Weapons System Approach to Air Data Computing *(Continued from page 44)*

tactical advantages offered by the improved attitude presentation and despite the apparent inferior reliability. Reliability has ultimately proved to be better than the old mechanically coupled instrument, an illustration that comparative reliability cannot always be based on intuition.

We have reviewed some of the inherent problems connected with arriving at an accurate and reliable air mass sensing and computing system. The future, with greater extension of flight envelope, will increase the complexity of such a system. It can readily be seen that an efficient weapons system would perform this measurement and computation in only one sub-system and share the data with the others. It is believed that the centralized air data computer is an important step toward increased efficiency of the complex machine.

However, the centralized air data computer will not cure all of the problems. Continued emphasis must be placed on overcoming the deficiencies of air mass sensing, particularly the problems presented by static source characteristics.

The present centralized air data computer is a device used exclusively to develop analogs of air data parameters. As such, it would be difficult to time-share the computing capability with problems and mathematical manipulations unrelated to air data found in other subsystems of the weapons system. The next logical step on the road to increased efficiency of the weapons system is that of a central computer, capable of solutions of many diversified problems on a time-share basis. It may be possible to take advantage of the great strides being made in the development of airborne digital computing techniques which offer advantages of time-sharing and programing flexibility. Recent development of memory or storage cells compatible with airborne requirements is encouraging.

In final summation, it is well to recognize the centralized air data computer as a logical advancement to the state-of-the-art. However, it should be recognized that we are at present on the left-hand end of the learning curve and successful attainment of our objectives of greater flying safety and greater P_k of the weapons system are contingent upon its continued development. The central air data computer is not and cannot be considered a separate entity since it is no better than its intelligence sources. It can only combine distinct parameters into prescribed mathematical forms and disseminate the result. Combination and dissemination is in the capable hands of equipment manufacturers. The accumulation of precise intelligence rests with the airframe manufacturer. If either falters, the weapons system is degraded.

The development of any weapons system is, of necessity, a series of compromises. There is no ideal solution. Compromises must be expressed in terms of their effect on P_k and crew safety. This is the job of the weapons system manager— to effect the optimum combination of compromises into a well balanced weapons system. The air data system described is one example of this approach in action.

XUM

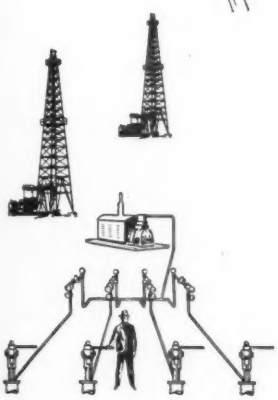
SARGENT

SYSTEMS OF FORCE CONTROL

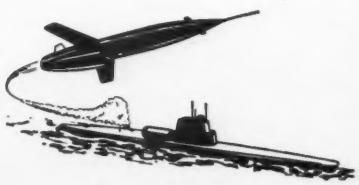
HYDRAULIC
PNEUMATIC
MECHANICAL
ELECTRONIC

Sargent Systems of force control are backed by more than 37 years of experience building precision equipment to meet the increasingly high requirements of the aircraft, guided missile, petroleum, gear and machine tool industries.

If your application of force control deals with aviation, marine, surface or subsurface movement, we invite you to send your requirements for the Sargent design, qualification and manufacturing proposal.



"GOOD WILL" is the disposition of the pleased customer to return to the place where he has been well treated.
— U.S. Supreme Court



Standard of Excellence *Since 1920*

Sargent offers exceptional opportunities to engineers interested in design, development, qualification testing, and manufacture of advanced forced control systems. Send your resume immediately (in confidence) to Chief Engineer.

Sargent
QUALITY BUILDS GOOD WILL

ENGINEERING CORPORATION
MAIN OFFICE & PLANT • 2533 E. FIFTY-SIXTH ST.
HUNTINGTON PARK, CALIF.

AS News *(Continued from page 15)*

Wylie M. Kimmons (A), formerly Aerodynamics Engineer, Convair Division (Fort Worth), General Dynamics Corporation, has joined Temco Aircraft Corporation as Engineer in Structures.

Cameron N. Lusty (AF), who formerly held engineering and technical management posts at Lycoming and Crosley divisions of Avco Manufacturing Co., has joined Avien, Inc., as Weapons System Consultant.

William C. McMillin (M), former Aerodynamics Design Engineer, Chance Vought Aircraft, Inc., has joined Temco Aircraft Corporation as Senior Engineer—Aerodynamics.

Peter Ovadias (M), formerly Chief, Engineering Department, Linea Aeropostal Venezolana, Caracas, Venezuela, was appointed Airline Operations Adviser to the Government of Israel on September 1, by the ICAO Technical Assistance Bureau.

William M. Shaffer (A) has been assigned to Redstone Arsenal, Huntsville, Ala., by Chrysler Corporation Missile Operations division as a technical writer on the Jupiter program. He formerly was assigned to Chrysler's Redstone program at Detroit.

William C. Webb (M), formerly Lead Design Engineer, Support Equipment, Chance Vought Aircraft, Inc., has joined Temco Aircraft Corporation as a Group Engineer in Support Equipment.

Beech Aircraft Corporation's new Super 18 executive transport for 1958, the largest the firm makes, is said to have all-weather capability, a range of 1,626 miles, a "high" speed of 234 m.p.h., and a cruising speed of 215 m.p.h. Engines are Pratt & Whitney R-985, 450 hp. each. Service ceiling is said to be 23,300 ft. at gross weight of 9,300 lbs., and 25,700 ft. at a gross of 8,750 lbs.

CORPORATE MEMBER NEWS

• **Aerojet-General Corporation** has announced the appointments of J. B. Cowen, formerly Executive Assistant to the Vice-President—Manufacturing, to Manager—Manufacturing, Solid Rocket Plant, Sacramento; and Fred S. Miller, Rocket Engineer, to Manager—Solid Rocket Propellant Production, Sacramento.

• **Allis-Chalmers Manufacturing Company** has announced the election of three vice-presidents—F. F. Bauer, E. J. Mercer, William M. Wallace—and a secretary, A. D. Dennis.

• **Aluminum Company of America** has announced installation of a new research facility in Chicago for fundamental study of die-casting processes.

• **American Airlines, Inc.,** has announced the following appointments: Walter J. Rauscher, Metropolitan Sales Manager, New York; F. R. Haverly, Director, Food and Catering Service; G. E. Coon, District Sales Manager, San Francisco; Eugene J. Murray, Director of Purchasing and Stores; and Rex Whitney, Auditor, Cargo Revenue Accounting.

• **Amphenol Electronics Corporation** has announced two new-type teflon tape dielectric coaxial cables.

• **Bendix Aviation Corporation** reports its low-frequency radio station, called the Bendix-Decca Navigator, is now in operation in the Nova Scotia and Newfoundland areas . . . . Robert S. Kinsey has been named Director of Engineering, Utica Division.

• **Boeing Airplane Company** has announced it will replace its design for the 717 transport with an improved version called the 720. The appointments of Ralph L. Bell and George R. Sanborn to the newly created positions of Military Transport Systems Manager and Director, Sales and Contracts, respectively, have been announced.

• **Curtiss-Wright Corporation . . .** Metals Processing Division has announced new techniques using the extrusion process to produce a variety of solid, intermediate, and hollow sections of heavy wall tubing for the nuclear, chemical processing, and petrochemical industries. The division reports it can produce extrusion tubing three times longer than any comparable tubing previously fabricated for commercial use.

• **Douglas Aircraft Company, Inc.,** has announced delivery of its 19,000th missile to the Air Force.

• **Fairchild Engine and Airplane Corporation . . .** Stratos Division has reshaped its sales and customer relations force, incorporating the Western Region as one of four basic subdivisions of the Stratos Customer Relations Staff. Charles W. Faas, formerly CR Manager, Eastern Region, has been assigned as CR Manager for all Stratos sales, contracts administration, and service operations and will assist General Sales Manager W. Thomas Stark in directing all four departments. Alexander D'Angio has been named CR Supervisor, Western Region. The division also has opened a Customer Relations office at 5057 Harbor Drive, San Diego, Calif. Louis W. Davis has been appointed Assistant to the President of the firm, succeeding William G. Key, who resigned. Robert M. Flanagan, former Chief Project Engineer, Stratos, has been promoted to a newly created position of Division Chief Engineer. George E. Ellis has joined Stratos in the new position of Industrial Products Manager.

Boeing Airplane Company's new model SAC bomber is designated B-52E. It has the same external appearance as its predecessors, but operates with improved bombing, navigation, and electronics systems.

LIGHTWEIGHT COMPONENTS...

for HIGHLY MOBILE missile support systems

The AiResearch units shown answer the need for high-output, lightweight and compact components to be incorporated in mobile ground support systems for tactical missiles. The Gas Turbine Compressor Power Unit, proved in service, supplies shaft and pneumatic power simultaneously. DC or AC electrical current for 60, 400 or 1200 cycles can be generated for missile checkout. Gas turbine power units can be started immediately and operated under all extremes of weather.

Among the additional functions which can be accomplished with AiResearch components and systems are: main engine starting; heating and cooling for equipment and personnel; air supply for pneumatic systems including missile pre-flight de-icing, vehicle wheel drives and other linear and rotational actuation; and energizing of hydraulic systems. Reliability and compatibility are assured by components and systems now in the field. Contact the nearest Airsupply or Aero Engineering office for further information.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

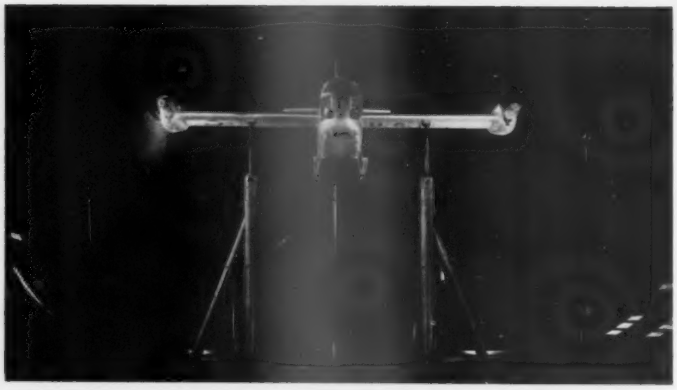
Los Angeles 45, California • Phoenix, Arizona

AERO ENGINEERING OFFICES:

MINEOLA • ATLANTA • BALTIMORE • BOSTON • CHICAGO • CINCINNATI • COLUMBUS
DETROIT • INDIANAPOLIS • PHILADELPHIA • ST. LOUIS • SYRACUSE • ORLANDO

AIRSUPPLY OFFICES:

BEVERLY HILLS • DENVER • FT. WORTH • KANSAS CITY • SAN DIEGO • SAN FRANCISCO
SEATTLE • TULSA • WICHITA



Bell Helicopter Corp. announced its XV-3 convertiplane has successfully completed full-scale wind-tunnel tests and has resumed test flying. The 120-hour wind-tunnel program was to check out stability, control, and vibration characteristics of the aircraft, which is equipped with a new two-bladed semirigid rotor system. Tests were made at NACA's Ames Aeronautical Laboratory.

• **The Garrett Corporation,** AiResearch Manufacturing Division, has announced the appointment of Budrick Schindler as Manager of Purchasing.

• **General Dynamics Corporation . . .** Convair Division has created two new departments at Fort Worth, Tex.: Customer Service, J. T. Cosby, Manager; and Spares Department, Robert Powelson, Manager. A new electronics cooling test stand simulating 100,000-ft. altitudes and producing 830°F. heat, for the F-106A, has been put into operation at San Diego, Calif. Ground training courses for USAF B-58 personnel have begun at Fort Worth.

• **General Electric Company...**Aircraft Gas Turbine Division has announced the appointment of Miles K. Wolfson as Manager, Engineering, Production Engine Department. Carl E. Anderson has been appointed Manager, Manufacturing, for the department, and Nicholas F. Frischhertz, Manager, Spare Parts and Engine Rebuild. John M. Heldack has been named Manager, Marketing, in the division's Aircraft Accessory Turbine Department.

• **General Precision Equipment Corporation,** Kearfott Company, Inc., has announced the election of three officials to higher positions: Frederick D. Herbert, Jr., to Executive Vice-President; Herman R. Stuart to Executive Vice-President; and Robert N. Brown to Vice-President and Director, Engineering.

• **The B. F. Goodrich Aviation Products, a Division of The B. F. Goodrich Company,** has named D. F. Homer Chicago District Manager.

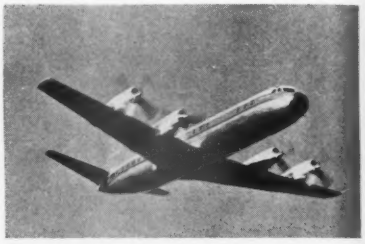
• **Grumman Aircraft Engineering Corporation** has announced Timmins Aviation, Ltd., of Montreal, will market the Gulfstream transport.

• **Kollsman Instrument Corporation** has announced receipt of orders for the firm's Integrated Flight Instrument System from BOAC for all Comet IV aircraft.

• **Lockheed Aircraft Corporation . . .** Georgia Division has announced it will design and build atomic reactors for power and heat not related to military needs. . . . Missile Systems Division has released statistics on the Q-5, recoverable ram-jet target missile: wing span 10 ft., length 39 ft., diameter 20 in., and weight 7,600 lbs. Three staff managers appointed to the project systems branch of the division are E. R. Proctor, Karl J. Wein, and Harry Windsor. Jobe Jenkins has been named Manager, Communications Department, for a weapon system technical division. Allen S. Dunbar has been named Staff Scientist, Antenna and Propagation Department. Richard S. Graham, Head, Nuclear Engineering and Development Section, has been named to an advisory capacity for the AEC.

• **Manning, Maxwell & Moore, Inc.,** has announced the appointments of Arthur W. Johnson, Manager, Ashcroft Guage Products; Jack E. Cox, Manager, Consolidated Safety Valves; and William H. Bolin, Manager, Product Planning, Consolidated Ashcroft Hancock Division.

• **The Martin Company** has announced the installation of Hydro-Tel milling machines at its Baltimore Division facility. The firm also has opened a new guided missiles and electronic systems plant near Orlando, Fla.



Lockheed Aircraft Corporation's Chief Engineering Pilot Herman R. Salmon flew the firm's Electra on its maiden flight. Lockheed reports the four Allison 501 propjets had the transport airborne after a run of less than 2,000 ft.

• **Norden-Ketay Corporation** has announced the appointment of Rear Adm. James F. Byrne, USN (Ret.), as Director of Material, Norden Laboratories Division.

• **North American Aviation, Inc.,** has announced the election of four executives as vice-presidents of the firm: Leland R. Taylor, also Assistant to the President, General Offices; Joseph G. Beerer, General Manager, Missile Development Division; John R. Moore, General Manager, Autonetics Division; and Samuel K. Hoffman, General Manager, Rocketdyne Division. . . . Autonetics Division has named Donn L. Williams Manager of its new Computers and Control Engineering Department, G. B. Way as Chief of a new Test Equipment Section, and R. G. Shelley, Manager, Fire Control Engineering Department. Autonetics also has established an integrated marketing organization, headed *pro tem* by Division General Manager John R. Moore and including two new functions—Market Planning and a Western Regional Office.

• **Northrop Aircraft, Inc.,** has announced that it will establish a small flight opera-

Ryan Aeronautical Company's VTOL "Vertiplane" employs the deflected slipstream principle to take-off without any ground run. Developed as an Army/Ryan research project, it is powered by a Lycoming T-53 gas-turbine engine located within the fuselage and has double retractable wing flaps which extend far below the wing trailing edge.

XUM

Is it possible to build a **MAN?**

"Theoretically, yes," said the scientist. "Or a reasonably remarkable imitation—a kind of mechanical analogue. Call it a habit machine, a mechanism operating according to the laws of the conditioned reflex."

You mean that you could actually build a mechanical mind? One that would exhibit emotions —such as love, fear, anger, loyalty?

"We're doing something like that now in advanced missile development," the scientist replied. "In a limited, highly specialized way, of course."

"Take the 'pilot' that is being developed for the big long-range missile. *He* has a wonderful memory, and can solve many complex navigational problems in a flash. *He* loves perfection, and actually becomes highly excited when *he* gets off course. *He's* a tough-skinned character, impervious to the cold at several hundred miles altitude and the incredible heat at re-entry. And *his* loyalty is heroic. *His* life is a single mission, the mission *his* whole life... and maybe ours, too. *He's* a pretty important *fellow.*"

What about the complete man-made Man? What would that entail?

"A mechanism the size of the capitol in Washington, and the best scientific resources in the world. But it could be done. You see, it's only a question of how physical matter is organized. As a great biophysicist explained, 'If material is organized in a certain way, it will walk like a man. If it is organized in another way, it will fly like a missile.'"

Still, wouldn't there be something missing in the complete man-made Man—something very important?

"Yes," said the scientist. "A soul."

MARTIN

BALTIMORE·DENVER·ORLANDO

tion at El Paso International Airport to support target missile programs of the firm's Radioplane Division facility.

• **Pan American World Airways, Inc.,** has named Abram W. French Curator in charge of the historical section of the firm's New York headquarters.

• **The Ramo-Wooldridge Corporation** has established its Space Technology Laboratories as an autonomous operating division, with Dr. Simon Ramo—who will relinquish duties as Executive Vice-President—as President. Other officers are Louis G. Dunn, Executive Vice-President and General Manager; and Ruben F. Mettler, Vice-President and Assistant General Manager.

• **Reaction Motors, Inc.,** has announced the acquisition of 28 acres of land at Lake Denmark, N.J., to provide for future expansion of the firm's test facilities and to serve to isolate development work on the X-15 rocket engine. Richard Frazee has been appointed Manager, Customer Relations, and Hunter C. Harrison, Washington Representative. George E. Thompson has been attached to the Washington office as Product Engineer. Ronald J. Banks was named to the same position at the Dayton, Ohio, office.

• **Republic Aviation Corporation** has formed a separate Helicopter Division to handle sales, service, and production of the Alouette II jet helicopter. Herbert H. Munsey, formerly Assistant Vice-President, Bell Aircraft Corporation, will head the new division as General Manager. Under license from Sud Aviation of France, Republic will sell the Alouette in this country, Canada, Alaska, Hawaii, Puerto Rico, and Central American countries. Others named to posts in the division are Gerald R. Rouillard, Sales Manager and Assistant to the General Manager; Frank H. Kelley, Director, Commercial Contracts; Robert W. Cary, Director, Military Contracts; and Thomas J. Mason, Chief Helicopter Test Pilot.

• **Servomechanisms, Inc.,** has announced the election of Page Golsan to the Board of Directors and the Executive Committee. Roger S. Estey has been named Head, Advanced Engineering Section, Western Subsystems Division.

• **Shell Oil Company** has announced a 4-year extension of the turbine fuel contract it has with Capital Airlines, Inc.

• **Solar Aircraft Company** has named Harold C. Donahue Applications Engineer, Gas Turbine Sales, Gulf Coast area.

• **Southwest Products Co.** has announced production of a new line of 550°F. self-aligning air duct joints for the aircraft, missile, and related industries. Data, specifications, and sizes are available from the firm at 1705 So. Mountain Avenue, Monrovia, Calif.

• **Sperry Gyroscope Company Division of Sperry Rand Corporation** has announced the appointments of William Bolster as Director, Plans and Systems; John M. Lester as Engineering Manager; and Robert C. Lyons as Sales Manager in Countermeasures, a group within the firm's Air Armament Division.

• **United Air Lines, Inc.,** has announced completion of a program to equip its entire fleet with airborne radar.

• **United Aircraft Corporation . . .** Pratt & Whitney Aircraft reports its nonafterburning J-75 turbojet has met or exceeded all performance estimates and guarantees during tests by the Navy. . . . New appointments in the Hamilton Standard Division's Electronics Department: Leland L. Antes, Senior Scientist; Charles B. Rheams, David L. Fridge, George E. Bowden, and C. J. Mueller, all Project Engineers; and William F. Mulcahy, Production Superintendent.

• **Vickers, Incorporated,** held its 7th Aircraft Hydraulics Conference in Detroit, November 12 and 13. William Patterson, Jr., has been appointed to the newly created position of Preliminary Design Engineer, Aero Hydraulics Division. A. L. Stone was named Western Region Sales Manager of the Division.

• **Vitro Corporation of America** has announced a new metallurgical technique for producing uniform, high-density molybdenum coatings based primarily on electrophoretic deposition.

• **Westinghouse Electric Corporation . . .** Air Arm Division has licensed California Technical Industries to manufacture its three-axis dynamic flight simulator and dynamic altitude simulator.

IAS SECTIONS

Chicago Section

Vanguard, Wind Tunnel Covered at Two Meetings

Some 300 members and guests heard Raymond H. Wilson discuss "The Vanguard Earth Satellite Program" on November 20 at a joint meeting of the Section, Mechanics Colloqium of Armour Research Foundation, and Illinois Institute of Technology. Dr. Wilson is in the Project Vanguard, Theory and Analysis Branch.

He reviewed most of the unclassified information on the satellite program and added that the controls system in the second stage will use a three-axis gyro reference system. The vehicle will be launched eastward and have the benefit of the earth's 1,340 ft. per sec. horizontal velocity. Ten minutes after take-off, at a range of 1,000 miles, it will be in orbital motion with a velocity of 25,000 ft. per sec. The satellite's plane will be fixed in space and have a period of about 100 min.

▶ Carl F. Schueller, Chief, NACA Lewis 10 × 10 ft. Supersonic Wind Tunnel Branch, described research with this tunnel at the October 23 meeting.

He said Lewis Flight Propulsion Laboratory is primarily engaged in power-plant problems, including special aerodynamics of high-speed flight propulsion. In the 10 × 10 ft. tunnel, air is moved through its test section by two large compressors turned by seven electric motors producing up to 250,000 hp. The air enters through a dryer building which removes moisture by heat and chemicals. Walls of the test section are 10 ft. wide, 78 ft. long, and $1^3/_8$ in. thick. Hydraulic jacks are used to move portions of these walls as much as $2^1/_2$ ft. each to form a variable nozzle for different air speeds. A two-story structure houses a muffler for silencing exhaust air. Air also can be recirculated into the tunnel.

Dr. Schueller also showed a film produced at Langley Laboratory—*Beating the Heat*—depicting problems in aerodynamic heating with models and metal specimens.

J. S. ISLINGER, *Secretary*

Dayton Section

Propulsion Systems Evaluated

Two speakers who discussed "Nuclear Flight Propulsion Systems" at the October 23 meeting were William C. Cooley, Acting Manager—Applications Engineering, General Electric Aircraft Nuclear Propulsion Department, and William R. Corliss, Nuclear Power Systems Specialist, G-E Flight Propulsion Lab. Some 175 members and guests heard the lectures.

Dr. Cooley gave a brief history of the national ANP program, reviewed certain aspects of the G-E program, and discussed potentialities and problems involved in developing ANP.

Mr. Corliss sketched a number of advanced propulsion systems including plasma jet, ion drive, photon drive, solar power, wireless transmission of power, free radicals, and the fuel cell.

He emphasized that a major technical breakthrough is needed for each of these systems before they become practical. A quality common to most of them is high specific impulses obtained only at the expense of immense power requirements.

JOHN S. MCCOLLOM
Secretary

Indianapolis Section

Students, Section Members Meet at Purdue University

Kent Campbell presented an illustrated lecture on the B-58 before 70 members at the annual joint dinner meeting of the Section and the Purdue University Student Branch.

Mr. Campbell, Convair, A Division of General Dynamics Corporation, prefaced B-58 movies with a description of weapons systems management partnership which played an important role in B-58 production.

R. J. H. BOLLARD, *Secretary*

Kansas City Section

Boeing Blown Flap Program

"Boundary-Layer Control for STOL" was discussed by John Aydalotte, Boeing, Wichita Division.

Mr. Aydalotte, in remarks to sor · 40 members and guests, concentrated on the Boeing-Wichita program involving the blown flap technique as applied to aircraft requiring under 500 horizontal ft. for take-off.

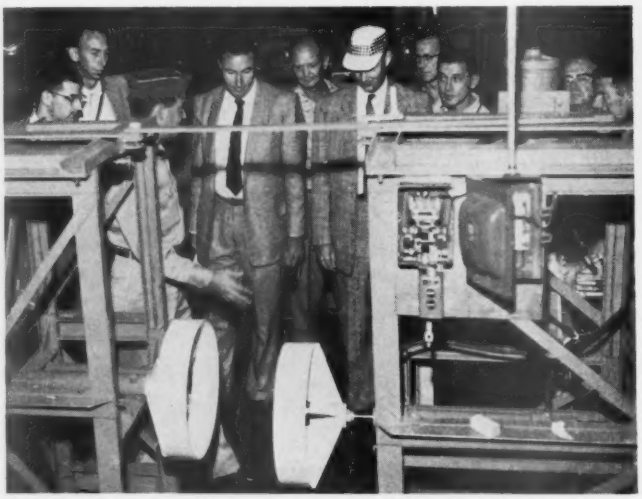
Slides demonstrating features of the Boeing study were presented with explanatory comments.

J. R. MACPHERSON
Secretary

Los Angeles Section

Details on Snark; Visit to Edwards AFB

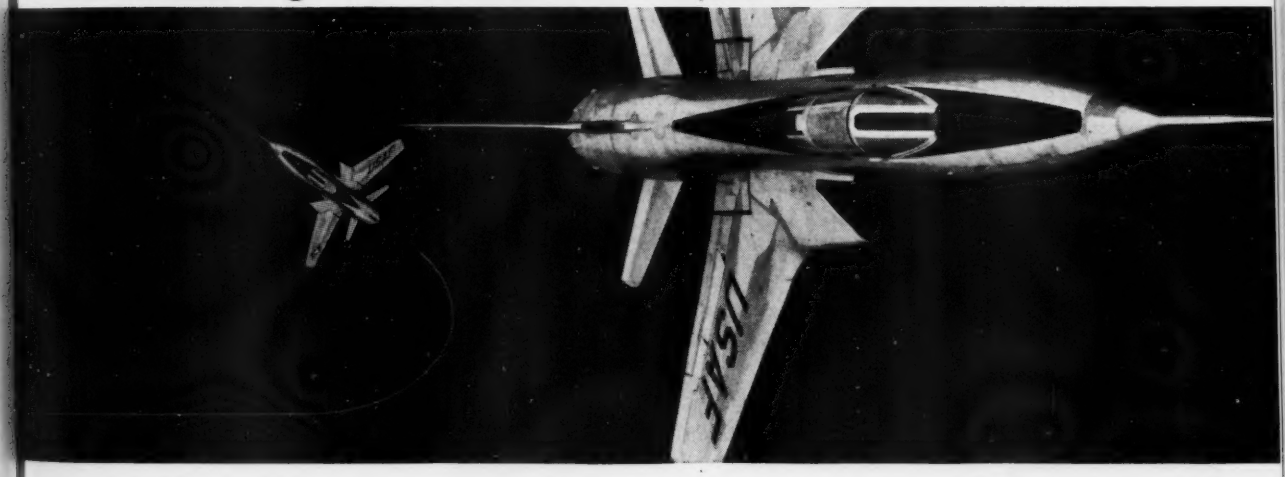
New Section officers installed at the October 17 meeting were Chairman—



Members of the Los Angeles Section are shown inspecting complex equipment used to service aircraft tested at Edwards AFB Flight Test Center, visited on October 9. Captain James F. Wilson, USAF, served as guide and lecturer during a tour of the maintenance and modification machine shops.

CONTROL

LMEE flight controls the Republic F-105-Thunderchief



LMEE-designed FC-5 flight control systems sense the effects of outside forces . . . correct for them with effortless, better-than-human speed. Assured of stability, relieved of basic control problems, the pilot is free to make his own essential contribution to mission effectiveness. ➤➤ LMEE's versatile FC-5 flight control system can be tailor-made as a single axis damper, or as a fully automatic flight control system linked to bombing, fire control, navigation, and ground control systems. ➤➤ Flight controls, along with many other LMEE electronic systems, help to power the peace. **Write for booklet, Dept. 2E**

LMEE

Progress Is Our Most Important Product

GENERAL ELECTRIC

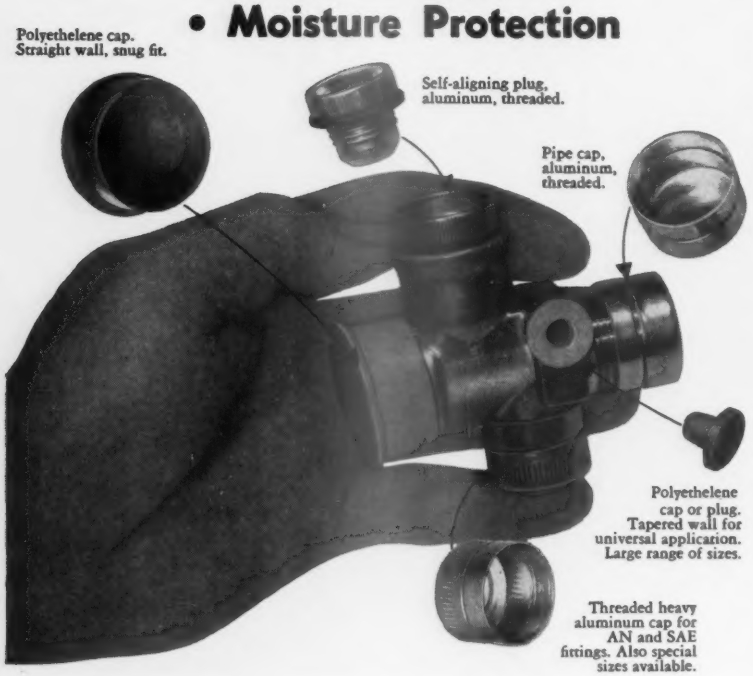
LIGHT MILITARY ELECTRONIC EQUIPMENT DEPARTMENT
FRENCH ROAD, UTICA, NEW YORK

A DEPARTMENT IN THE DEFENSE ELECTRONICS DIVISION

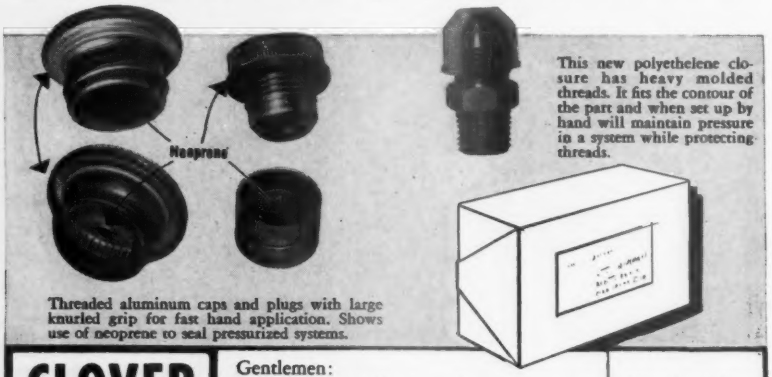
XUM

These PLUGS & CAPS are easily hand tightened

For
- Pressure Seal
- Thread Protection
- Moisture Protection


Polyethelene cap. Straight wall, snug fit.
Self-aligning plug, aluminum, threaded.
Pipe cap, aluminum, threaded.
Polyethelene cap or plug. Tapered wall for universal application. Large range of sizes.
Threaded heavy aluminum cap for AN and SAE fittings. Also special sizes available.

When you buy Clover Closures you buy the best in tight fitting protection. They are made in polyethelene and metal for internal and external applications. Tight fitting design, seals out moisture, dirt and gives dependable thread protection. Metal closures with neoprene rings or discs can be used to seal unit and hold relatively high pressures. For the newest in closures always specify CLOVER! Special closures engineered to your requirements.


Neoprene
This new polyethelene closure has heavy molded threads. It fits the contour of the part and when set up by hand will maintain pressure in a system while protecting threads.
Threaded aluminum caps and plugs with large knurled grip for fast hand application. Shows use of neoprene to seal pressurized systems.

CLOVER Industries, Inc.

592 Young Street
TONAWANDA, NEW YORK

Gentlemen:
Please send your idea box of Clover Closures.

Name_____
Company_____
Address_____
City_____ Zone____ State_____

I am interested in:
Plugs
Caps
In Metal
In Plastic
With Neoprene seal
Thd. Size_____

DEPARTMENT OF TECHNOLOGY
BUFFALO AND ERIE COUNTY PUBLIC LIBRARY

M. C. Haddon, Chief Engineer, Lockheed (Burbank); Vice-Chairman—Mal Abzug; Secretary—Dana Moran; Treasurer—Earle Hodder; and Program Chairman—Don Justice.

William F. Ballhaus, Vice-President and Manager, Nortronics Division, Northrop, discussed his firm's Snark missile program, giving detailed data on its design requirements and concept and a review of the flight-test program.

E. P. Wheaton, Douglas Chief Missiles Engineer, presided as chairman and introduced Lt. Gen. L. C. Craigie, USAF (Ret.); Col. R. A. Trennert, former Chief, Los Angeles ARDC Field Office; and Col. Paul May, incoming Chief.

▶ Some 320 members and their families saw films on the T2V-1 Lockheed Jet Trainer, F-84 Parasite Fighter, Douglas Skyhawk, Nike, and Viking rocket at the October 25 historical meeting.

▶ On October 9, 150 members were guests of the USAF Flight Test Center, Edwards AFB, where they inspected century series aircraft and watched a rocket sled test. They also visited the modification and maintenance hangar.

A. W. Trimpi of Northrop gave a paper on "The Hecker Method of Interior Temperature Calculations" at the October 8 specialists meeting. He discussed means for approximating interior structural temperatures and the handling of practical aircraft constructions such as skin-stringer, multiweb, or honeycomb.

H. D. Moran, *Secretary*

Philadelphia Section

Long-Range Planning for Industry and Government

More than 200 members and guests at the November 6 meeting heard Felix A. Kalinski, Manager, Long-Range Planning, Vertol Aircraft Corporation, describe his specialty as an art rather than a science.

Dr. Kalinski, speaking at a joint dinner meeting with the Franklin Institute, said such planning is a tool to assist administrative judgment. It has assumed an increasingly important role in modern industry and government and for the corporation can mean the difference between success and mediocrity.

W. Welsh Godon, *Secretary*

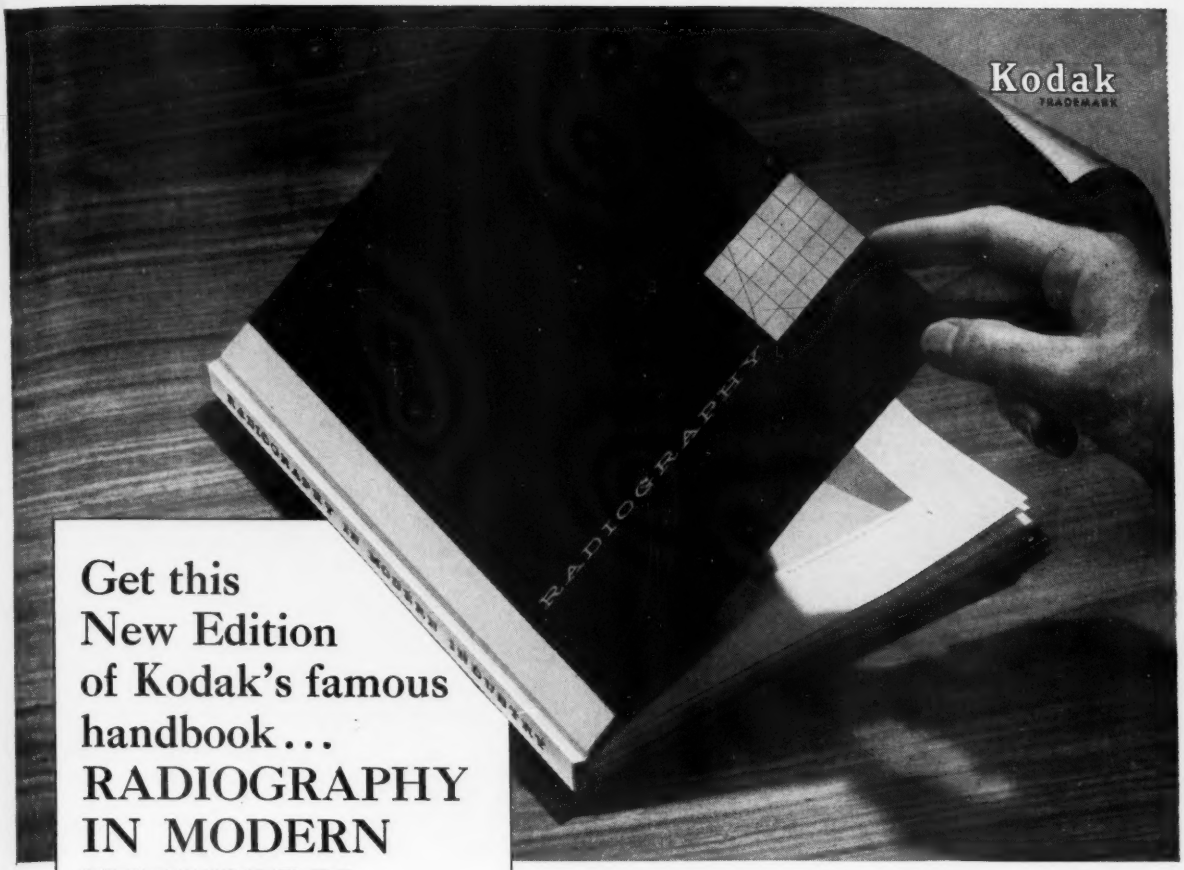
Rocky Mountain Section

Shapley Discusses IGY

Alan H. Shapely, IGY Vice-Chairman and Radio Physicist, Boulder Laboratories, National Bureau of Standards, spoke on "IGY in Progress" before 185 members and guests on October 10.

He discussed some of the less publicized aspects of the program including seismological, meteorological, ionospheric, and oceanographic measurements and the relationships between solar flare and magnetic disturbances on the earth. He also showed photos of IGY preparations in Antarctica.

Members approved a Permanent Advisory Board as follows: Frank Cook, Frank R. Cook Co.; Prof. K. D. Wood,



Get this New Edition of Kodak's famous handbook... RADIOGRAPHY IN MODERN INDUSTRY

An authoritative, up-to-the-minute text which explains the fundamentals of x-rays and gamma rays, and their use in radiography for industry.

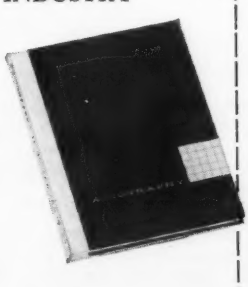
Everyone interested in industrial radiography should have the latest edition of this famous handbook. It contains all the information found in the previous text, plus up-to-the-minute additions. It tells about new technics, new sources of radiation, and new fast films; explains proper methods of using them.

No one engaged in radiography should be without this latest edition of *Radiography in Modern Industry*. Get it from your Kodak x-ray dealer, or send coupon below.

EASTMAN KODAK COMPANY · *X-ray Division* · Rochester 4, N. Y.

RADIOGRAPHY IN MODERN INDUSTRY

- size 8½ x 11 inches
- hard cover, case-bound
- 140 pages of information
- 15 chapters
- 101 text illustrations
- 19 tables
- appendix
- bibliography
- cross index
- Price, $5.00



EASTMAN KODAK COMPANY
X-ray Division, Rochester 4, N. Y.

Gentlemen: Enclosed is $5.00. Please send me "Radiography in Modern Industry."

235-2

Name _____

DEPARTMENT OF TECHNOLOGY
BUFFALO AND ERIE COUNTY PUBLIC LIBRARY

Address _____

City _____

State _____

XUM

C. George Young, Scientist in the Research Department for Nuclear Electronic Applications, McDonnell Aircraft, spoke on "Atomic Energy in the Aircraft Industry" at the October 23 meeting of the St. Louis Section.

University of Colorado; H. D. Fowler, Aeronautical Consultant; Richard Olson, Sundstrand—Denver; Richard Bosworth, Beech Aircraft Corp.; Frank Norton, The Ramo-Wooldridge Corp.; Allen Bonnalie, United Air Lines, Inc.; and Allison Arnold, Stanley Aviation Corp.

Section officers elected for the coming year were Chairman—Colonel Dane; Vice-Chairman—Lawrence Soderberg, Beech Aircraft; Secretary—Donald Knowlton, General Electric Co.; and Treasurer—Henry St. John, Sundstrand.

DONALD A. KNOWLTON, *Secretary*

Seattle Section

3,000-m.p.h. Wind Tunnel Visited at Boeing

A tour, demonstration, and discussion of Boeing's new supersonic wind tunnel highlighted the October 30 meeting. T. A. Wilson, Seattle Section Vice-Chairman and Assistant Chief, Technical Staff, Boeing Seattle Division, discussed design and procurement of the tunnel. He was assisted in the technical description of aerodynamic design and instrumentation by R. B. Hildebrand and G. H. Cheney.

The facility is to meet a large percentage of Boeing requirements, but specialized testing in other facilities still will be performed.

S. M. LITTLE, *Secretary*

St. Louis Section

General Gregory Speaks on Exploratory Research

General H. Franklin Gregory discussed "Exploratory Research" at the November 20 meeting. He is Commander, Air Force Office of Scientific Research.

He said current complex missiles and aircraft designs attest to past activities in R&D and that space travel can be achieved only by further R&D. He said his office is working throughout the world on exploratory research. Some items of interest include fuels and propulsion systems, high-temperature effects, and biological effects at high altitudes. He also explained Project Far-Side problems and accomplishments.

▶ "Balanced Weapons Systems—The Case of the Naval Interceptor" was discussed by Charles M. Forsyth on November 13. Mr. Forsyth is Manager, Customer Service, McDonnell. He presented the same paper given at the IAS Naval Aviation Meeting last year.

▶ The unclassified side of "Atomic Energy in the Aircraft Industry" was discussed by C. George Young, Research Department for Nuclear Electronic Applications, McDonnell Aircraft, at the October 23 meeting.

His talk was primarily on the peaceful uses of atomic energy, confining nuclear weapons to definition only. The different types of radiation and their effects on the human body in various doses were also discussed.

Television Series

Six television programs titled "The Way to Flight" were produced by the Section on St. Louis' educational station KETC, during the past year, to arouse interest in aeronautics in youngsters from 12 to 18 years.

The entire series was planned and cast by members of the Television Committee and was one of several civic projects backed by the Section. The 30-min.-long programs were presented each week in two parts—a discussion-lecture and model building session. An expanded series of programs has been scheduled this year.

H. H. LUETJEN
Recording Secretary

Texas Section

Satellite Review

J. W. Joyce spoke on November 13 on "The Scientific Earth Satellite." Dr. Joyce is Head, Office for the International Geophysical Year, National Science Foundation, Washington, D.C.

He reviewed unclassified IGY facts. The satellite as a research tool has been compared in importance to the optical telescope and the high-energy nuclear accelerator, he said.

Atomic Submarines

The application of aeronautical design principles to modern submarines was discussed by Capt. C. W. Nimitz, Jr., USN (Ret.), at the October 25 meeting.

Captain Nimitz, associated with Texas Instruments, Inc., spoke on "A Submariner Looks at Aviation." Citing the Nautilus class, he said the Navy has had to design fantastic underwater endurance into its submarines because of progress in aviation.

During a question period, Captain Nimitz said he felt an effective aircraft-submarine team will be developed to hunt and kill enemy submarines.

M. V. RICCIUS, *Secretary*

Tullahoma Section

Pfenninger, Groth Discuss BLC

Werner Pfenninger and Eric Groth of Northrop Aircraft, Inc., gave a classified lecture on "Laminar Flow Boundary-Layer Control" at the October 24 meeting. Dr. Pfenninger is Chief, Boundary-Layer Control Department; Dr. Groth is an Engineering Specialist.

Dr. Pfenninger's paper considered BLC in subsonic flow. Dr. Groth discussed BLC in supersonic flow.

▶ Jack T. Shea, Special Assistant to the Managing Director, ARO, Inc., presented a discussion on "Wilbur, Orville, You, and Communications" at the November 14 meeting.

H. A. REICHMANN, JR.
Secretary

Tulsa Section

Human Factors in Space Flight

Nearly 100 members and guests were intrigued by "Human Factors in Space Flight," a talk given by E. B. Konecci, at the November meeting. Dr. Konecci is Head, Human Factors Group, Douglas Aircraft Tulsa Division.

He explained the dangers involved in three catagories. Physiologically, the astronaut will be confronted with weightlessness, solar and cosmic radiation, an artificial atmosphere, acceleration, and deceleration. The major physical hazard will be meteorite bombardment. Psychologically, claustrophobia and prison complexes are the chief concern. To make the space ship livable, methods must be developed for the supply of oxygen, food, and water and for disposing of waste materials.

Dr. Konecci believes that man must go into space in a "safe" cabin, safeguarded without the space suit which complicates eating, bathing, and normal functions.

J. T. FARRAH
Secretary

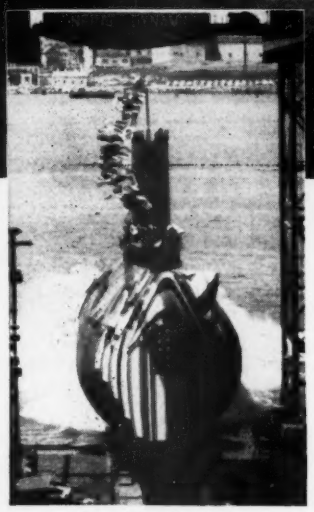
Washington Section

Army Aviation Goal Is Agility

A comprehensive view of Army aviation was presented at the October 16 meeting along with a demonstration of Army fixed- and rotary-wing aircraft at Davison Air Field, Fort Belvoir, Va.

XUM

Electrolized for Reliability...



Launching the Skate
at General Dynamics Corporation's
Electric Boat Division Shipyard

The Skate, third U.S. atomic submarine, slides down the ways at Groton, Conn., leaving behind its future nuclear companions, Skipjack and Triton.

Photo courtesy Electric Boat Division

. . . maximum wear life, minimum friction and increased corrosion resistance imparted to critical wear parts in U.S. Nuclear Submarine Fleet

Reliability of mechanisms in the Skate, the nation's third nuclear submarine, is heightened by specification of Electrolizing on more than fifty different critical wear parts. Exhaustive testing prior to specification established that Electrolizing provides superior anti-seizure characteristics . . . an extremely low coefficient of friction . . . remarkable wear resistance . . . and beneficial resistance to corrosion.

Wherever reliability is a primary consideration, Electrolizing is the answer. The Electrolizing deposit is an extremely hard (70-72Rc), dense, non-magnetic alloy which can be applied to both ferrous and non-ferrous metal surfaces. It has no adverse effect on the basis metal . . . can be held to a tolerance of .000025" . . . cannot be separated from the basis metal by peeling, chipping or flaking . . . does not "build-up" or cause nodulation on sharp edges . . . and can be held to two light bands flatness.

Four Electrolizing plants conveniently serve all U.S. industrial centers with delivery "as scheduled".

For complete data, send for new 24-page booklet. ▶

THE *Electrolizing* CORPORATION

1505G East End Avenue • Chicago Heights, Illinois

Other Plants Located at:

Providence 1, R.I.
148 W. River St.

Cleveland 12, Ohio
1325 E. 152nd St.

Los Angeles 21, Calif.
1406 East 15th St.

MAIL COUPON FOR FREE COPY

The Electrolizing Corporation
1505G East End Ave., Chicago Heights, Ill.

Please send new 24-page booklet.

Name.....

Company.....

Telephone No.....

Street Address.....

City.....Zone....State.....

DEPARTMENT OF TECHNOLOGY
BUFFALO AND ERIE COUNTY PUBLIC LIBRARY

Major Generals S. R. Browning and H. H. Howse and Col. G. P. Seneff were guest speakers. General Browning is Deputy Chief, Transportation Department; General Howse is Director, Army Aviation; and Colonel Seneff is Assistant Chief, Aviation and Electronics Division Office, Deputy Chief of Staff for Military Operations.

Comments by General Howse were: Army Aviation must be responsive to Command requirements, and the equipment must be operable and maintainable in the field; he outlined six basic missions to be fulfilled and said, "The key word in Army Aviation is 'agility.'"

Colonel Seneff discussed R&D, covering mainly VTOL aircraft. General Browning spoke on the logistics problem from the view of limited funds necessitating careful planning. He said the Army is contemplating a system whereby the equipment manufacturer, through his distributors, will furnish parts on open call contracts. Also, the Army is compiling a designer's guide to get an end product as trouble-free as possible.

FLOYD J. SWEET, *Secretary*

Wichita Section

Organization, Communication Management Virtues

I. Nevin Palley, Vice-President—Engineering, Temco Aircraft, discussed "Programing, Scheduling, and Evaluating Engineering Assignments—The Feedback Approach" at the October 2 meeting.

Mr. Palley described his subject in the simple terms of "how to run an engineering organization." He pointed out that organization is analogous to a servomechanism. The prime variables in management are organization and communication. The latter is the more important because the function of the organizational chart is to facilitate communication.

The "closed loop" system or "feedback approach" provides a means of measuring, comparing, and evaluating the output during the output, he said. Corrective signals are then fed back into the design system, and new output is obtained.

H. W. SMITH, *Secretary*

STUDENT BRANCHES

Agricultural & Mechanical College of Texas

The second meeting was held on October 22, when some 40 members heard a talk by Frank S. Barrett, Flight Test Engineer, Chance Vought Aircraft Company.

Mr. Barrett described the role of the Flight Test Engineer and the importance of his job to the airframe contractor. He also explained his responsibilities and his necessity for sound judgment.

A film, *Operation One Grand*, was shown after the lecture.

Brown University

Some 100 members and guests heard an address by Frederick R. Riddell, Avco Research Laboratories, at the November meeting.

Dr. Riddell spoke on "Future Developments in Man-Made Satellites" and illustrated his talk with slides. He said that America's research should be devoted to the goal of manned space flight and that this obviously was Russia's goal.

Dr. Riddell concluded that our immediate goal should be the launching of test satellites leading to the development in turn of manned re-entry satellites. He saw no substantial scientific reason for delay.

DANIEL C. DUNLAP, *Secretary*

California State Polytechnic College

Some 100 members and guests heard William A. Coleal at the November 7 meeting. Mr. Coleal, a propulsion systems instructor in the college Aeronautical Engineering Department, spoke on "Flight Testing the F-104 Propulsion System" and explained the reasons for extensive flight testing as against the static ground test.

While test cell operating conditions are nearly ideal, various flight-operation phenomena can be measured only under the actual flight conditions. Among other items, the flight-test engineer must contend with inlet induction losses, accessory power plus compressor air bleed losses, and exhaust system losses.

Mr. Coleal went on to explain some of the features of the propulsion system installation in the F-104 aircraft. The two prototypes had a two-dimensional ramp-type inlet. The F-104A has a three-dimensional semiconical inlet. The prototypes were first powered with J-65 engines without afterburners. Subsequent engine installations employed the J-65 with a Lockheed-developed afterburner. The final prototype engine configuration was a J-65-W18 afterburning engine developed by Curtiss-Wright.

In the F-104A, the shock-wave geometry problem was handled by utilizing the internal air by-pass principle wherein the shock-wave system is maintained at optimum position for maximum thrust minus drag by by-passing excess air around the engine into a secondary path to cool the aft fuselage and increase jet nozzle performance.

The speaker concluded his address by presenting a Lockheed film, *XF104 Progress Report*.

On October 17, some 75 persons heard an address by Philip McLane, Chief Engineer, Fletcher Aviation Corporation.

Mr. McLane spoke on "Problems and History of In-Flight Refueling." He briefly explained two systems and some of their advantages and disadvantages.

Test Engineering at Marquardt

by
Roy E. Marquardt
President

Unique among air-breathing engines, the ramjet cannot run independently on the ground. Because ramjets depend on their velocity through surrounding air masses for compression of combustion air, intricate test facilities must be provided.

Marquardt Jet Laboratory simulates these high-speed, high-altitude flight conditions during ground testing. A USAF facility, combined with special USN test facilities, MJL is one of the most extensive in existence today. Valued at $18 million and occupying 8 acres of land, this dynamically functional engineering tool minimizes the number of costly trial and error flights of new engines.

Complex test cells, with associated instrumentation and computers, permit sea-level and altitude testing of full size and test-scale models. In our two sea-level test cells, high pressure air is directed over the test engine through subsonic, sonic, and supersonic nozzles, and exhausted to the atmosphere. Turbojets are ingeniously utilized in two full scale engine altitude test chambers to simulate heated and rarefied air conditions encountered by high-flying supersonic ramjets.

Special configurations in both sea-level and altitude cells permit angular motion of the free jet nozzles. This allows evaluation of the effects of varying angles of attack likely to be encountered by operational engines.

A new production acceptance test facility now being built in conjunction with our Ogden production plant will greatly supplement the up-to-the-minute equipment furnished the Marquardt Test Team.

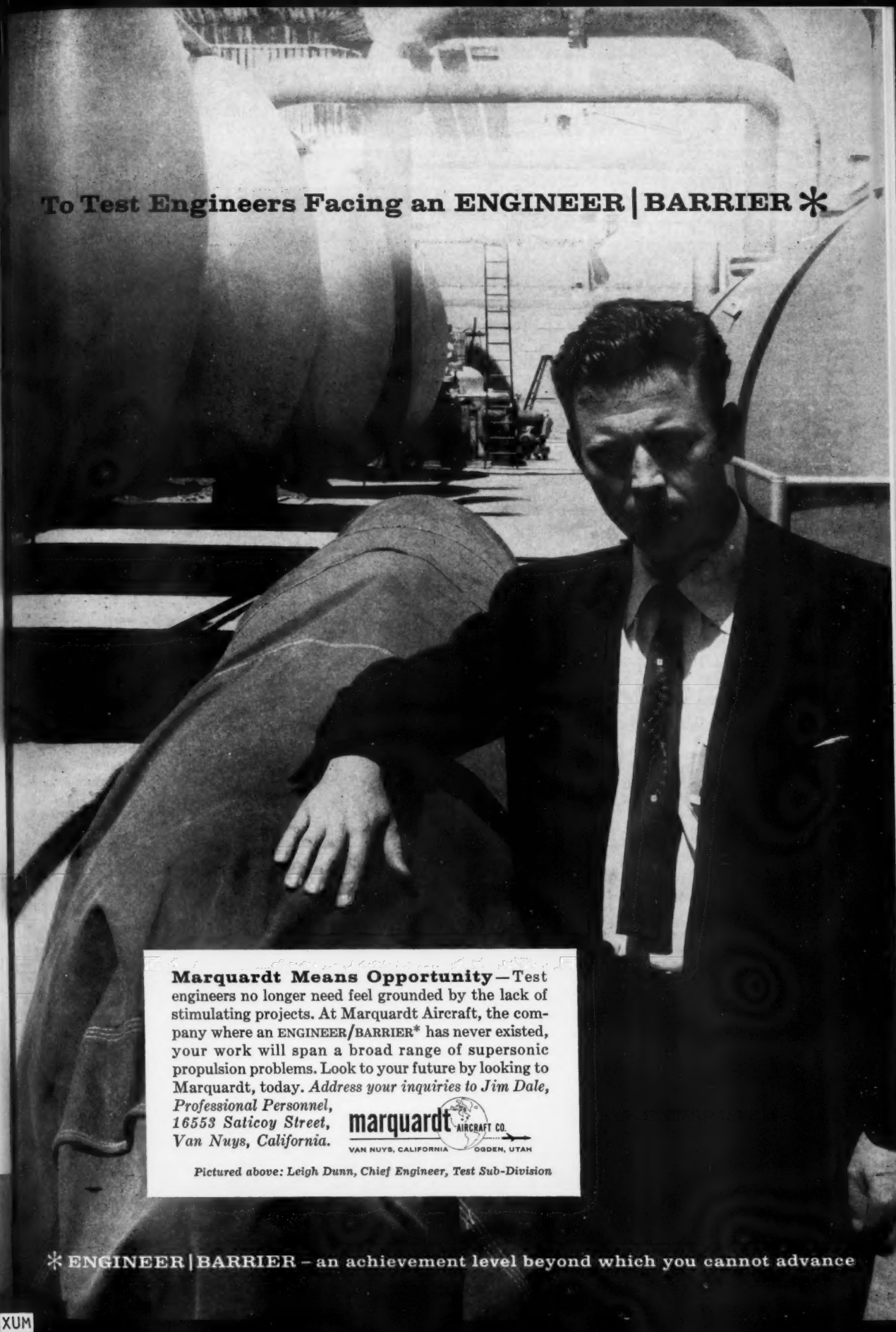
Within this Division, engineering openings exist for:

MECHANICAL ENGINEERS AEROTHERMO ENGINEERS
ELECTRICAL ENGINEERS CONSTRUCTION ENGINEERS

For information about these positions and the professional engineering environment at Marquardt, we invite you to write Jim Dale, Professional Personnel, today.

Roy E Marquardt

marquardt AIRCRAFT CO.
VAN NUYS, CALIFORNIA OGDEN, UTAH
FIRST IN RAMJETS



Marquardt Means Opportunity—Test engineers no longer need feel grounded by the lack of stimulating projects. At Marquardt Aircraft, the company where an ENGINEER/BARRIER* has never existed, your work will span a broad range of supersonic propulsion problems. Look to your future by looking to Marquardt, today. *Address your inquiries to Jim Dale, Professional Personnel, 16553 Saticoy Street, Van Nuys, California.*

marquardt AIRCRAFT CO.
VAN NUYS, CALIFORNIA OGDEN, UTAH

Pictured above: Leigh Dunn, Chief Engineer, Test Sub-Division

* ENGINEER | BARRIER – an achievement level beyond which you cannot advance

The "flying boom" system was developed by Boeing. Fletcher Aviation's work is with the "probe and drogue," which was first used in England. Mr. McLane stated that advantages of this system over the "flying boom" type are higher flight speeds at higher altitudes, greater adaptability to smaller aircraft as well as large, and multiplane installations.

He concluded by showing a Fletcher film, *Introduction-FR250 Hose Reel.*

JERRY MITVALSKY, *Secretary*

Indiana Technical College

Some 20 members visited Bendix Aviation facilities at South Bend, Ind., on November 1. They saw assembly lines and some test sections of various components made at the plant.

A film, *Of Wings and Men*, was shown after a business meeting on October 29.

HERBERT D. KREDIET, *Secretary*

Institute of Technology, USAF

At a meeting held on October 28 in the AFIT auditorium, some 100 members heard "The Pilot Protection Controversy," an address given by Capt. Dan Fulgham, Physiology Section, Aero Medical Laboratory, ARDC. Captain Fulgham discussed the problems of pilot protection available now and in the future.

Proposed solutions involve either a pressure suit or a capsule-type cockpit. The pressure suit offers excellent protection but renders the pilot practically immobile. The cockpit capsule also has excellent protection capabilities, but the danger of explosive decompression, especially in combat, requires a secondary mode of protection. The best possibility seems to be a combination of the two, he said.

The open ejection seat is impractical for the altitudes and air speeds of the future, therefore some method must be found for protecting the pilot from windblast, hypoxia, and freezing during the escape and free fall phases of an ejection. Solutions discussed included seat and cockpit capsules.

CAPT. DAVID W. HALL, USAF, *Secretary*

Louisiana State University

Major A. J. Busalacchi, USAF, spoke before 20 members and guests at the November 14 meeting. He is a Senior Navigator assigned to the University as a member of the AFROTC Detachment.

Major Busalacchi discussed polar navigation and its importance to our national defense. He listed several types of navigation: pilotage, celestial, radio, and radar.

▶ Edwin B. O'Neill, a Branch member, addressed 25 members and guests on October 31. He traced the evolution of the aircraft carrier from the small, top-heavy early carriers to the long, canted deck carriers of today.

Mr. O'Neill also discussed three of the latest advances in Naval aviation: the canted deck, the steam catapult, and the variable incidence wing.

DOUGLAS D. DUHON, *Secretary*

Massachusetts Institute of Technology

A film, *The Model 707 Stratoliner, Stratotanker*, was shown at the November 12 meeting. This film, which may be obtained from the Boeing Airplane Company, illustrated the first flight and testing program of the 707.

WILLIAM TOWLE, *Secretary*

Mississippi State College

Some 80 students at the October 3 meeting met newly elected officers and heard plans for the fall semester outlined.

Officers for the 1957–58 school year are Walter H. Parks, Chairman; Howard L. Hutcherson, Vice-Chairman; James T. Cooper, Treasurer; David L. Simpson, Corresponding Secretary; and Georg K. Timm, Recording Secretary.

Later, a color film of the B-58 Hustler was shown and a discussion held on flight testing.

GEORG K. TIMM,
Recording Secretary

New York University

The October 28 meeting was devoted to Branch business—Mr. Feigel was elected Vice-Chairman and committees were formed for the year.

Four tentative smoke tunnel projects were presented to members, and several volunteered to work on projects such as model making, calibration, and photography. Faculty Adviser Professor Storm has been scheduled to discuss technical details involved in these projects.

▶ Herbert Becker, Solid Mechanics Branch, N.Y.U. Research Department, was guest speaker at the October 14 meeting. In "Stress Analysis of Aircraft" he outlined some of the problems inherent in resolving forces on an aircraft and mentioned as a case in point the problem of shear lag in wing structures.

▶ The first Branch meeting on September 30 saw new officers installed. They were Marvin Barkin, Chairman; Martin Sherman, Treasurer; and Isaac Fernandez, Secretary.

The Branch has secured permission to use a smoke tunnel in the Aero Department and may now seriously consider a series of low-speed experiments.

ISAAC FERNANDEZ, *Secretary*

North Carolina State College

Forty members at the meeting on November 12 heard Robert O. Schwantes, Chief, Structures Group, Douglas Aircraft Company (Charlotte, N.C.).

"Some Problems of Guided Missile Structure" were explained. Requirements used to judge a missile design are past experience, a growth factor, and the present state of the art. One of the basic problems mentioned was the warping of surfaces due to structural divergence when the surface is exposed to high temperatures. Materials as varied as ceramics, glass, plastics, prestressed concrete, and beryllium are being investigated.

▶ Earl J. Bruns, Manager, Westinghouse Engineering Development Laboratory, discussed altitude chambers at the October 22 meeting.

▶ L. M. Epps, Assistant to the Chief Technical Engineer, Grumman Aircraft Engineering Corporation spoke on "Opportunities for Engineers In the Aviation Industry" at the October 8 meeting.

A movie, *Grumman Presents the Tiger*, was shown after his talk. This depicted the history of the aircraft from mock-up to production.

RICHMOND P. BOYDEN,
Corresponding Secretary

Oklahoma State University

The Branch began semester activities with a simple pledge program designed to attract new members and publicize IAS student activities. The program proved successful since 18 new members were inducted.

New officers elected for the semester are Warren Gilmore, President; Charles Cummings, Vice-President; Ron Johnson, Recording Secretary; and Pat Wyres, Treasurer.

TOM FUJIYOSHI,
Corresponding Secretary

Parks College of Aeronautical Technology

At the November meeting, student members and guests heard John F. Mello, Aerodynamics Engineer, McDonnell Aircraft Corporation, on "Aerodynamic Design Problems Associated With a Large Flight Mach Number Range."

Mr. Mello pointed out that aerodynamic configurations which perform satisfactorily for a large range of flight Mach Numbers are required on many missiles since the trend is toward increasing effective top speed while maintaining a relatively low effective minimum speed. He said that one of the most difficult problems occurred in providing adequate stability and control without increasing power requirements and without degrading overall missile performance.

GERALD E. CHMIELEWSKI, *Secretary*

The Pennsylvania State University

E. I. Weber, Head, Weight Optimization Section, The Martin Company, discussed his specialty before 35 members at the October 24 meeting. He used several examples to show why it is necessary to control structural weight in aircraft, referring to the Martin SeaMaster and the Vanguard rocket.

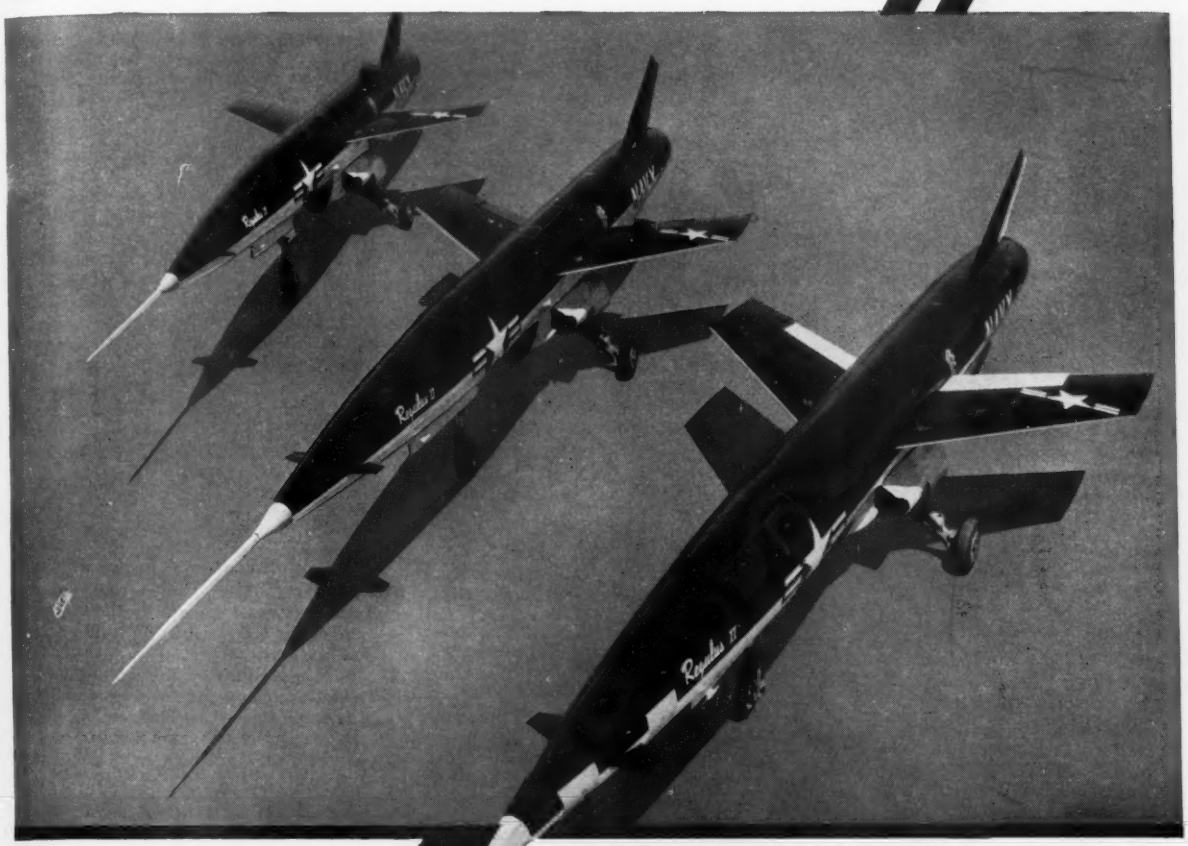
On October 17, Fred Strickland, Chief Design Engineer, Piper Aircraft Corporation, discussed problems that arise in industry that an engineer is not trained in college to meet. This was illustrated by the example of a small change in a minor component which results in modification of major components. His reference was to the Piper Comanche.

ROBERT E. HENDERSON, *Secretary*

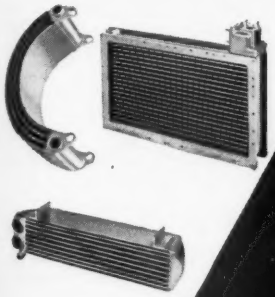
Polytechnic Institute of Brooklyn

The Branch was joined by student members of the American Rocket Society on

REGULATES HEAT ON REGULUS II



Harrison aircraft oil coolers—engineered and built to General Motors standards of quality.



Harrison-Cooled Regulus II Flies More Than Double The Speed of Sound

The Navy's new Regulus II zooms into space at a blistering speed—to altitudes of more than 60,000 feet! And Harrison heat exchangers are on board, providing the optimum in oil-cooling efficiency—safeguarding engine performance on these spectacular Chance Vought flight test vehicles. Backed by over 47 years' experience, Harrison heat exchangers are rugged, reliable and compact—designed to assure complete dependability under the most severe operating conditions. That's why you'll find Harrison heat transfer equipment on so many of America's foremost weapons of defense—from atomic submarines to supersonic bombers and guided missiles.

If you have a cooling problem, look to Harrison for the answer.

TEMPERATURES MADE TO ORDER

HARRISON

FROM THE PROGRESS OF THE PAST... GM ...THE PROMISE OF THE FUTURE

HARRISON RADIATOR DIVISION • GENERAL MOTORS CORPORATION • LOCKPORT, N. Y.

December 3 to hear Major David G. Simons discuss "Human Factors in High-Speed, High-Altitude Flight." Major Simons ascended to 100,000 ft. in a balloon in connection with research at the Aeronautical Field Lab, Holloman AFB.

He said the staff there is interested in manned space travel, primarily from the point of view of what man will be able to do once he gets into space. He showed a film of his record ascent (*Operation Manhigh II*) and told of his personal impressions at the time.

▶ Some 30 members visited Sikorsky Aircraft facilities on November 15. They saw the S-58 helicopter production line where it was pointed out that the entire weight of the aircraft is supported by four steel "A" frames which join the rotor head to the fuselage.

▶ At the November 12 meeting the film *Design and Testing of Supersonic Flutter Models* was shown.

The Branch and its ARS counterpart visited Bell Aircraft facilities in Buffalo, N.Y., on November 8. Members saw films of the Bell X-1 and X-22 aircraft and heard talks on combustion, rocket design, and missile instrumentation, by Bell department heads. High point of the visit was the firing of a 5,000-lb. thrust rocket.

▶ *Harnessed Lightning*, a film about the Allison J-57 turbojet engine, was shown at the October 22 meeting.

▶ Ed Marciniak of Grumman Aircraft Engineering Corporation spoke on "The Martin-Baker Ejection Seat" at the October 15 meeting. Mr. Marciniak is a Flight Test Engineer.

A "95 per cent human" dummy ejecting from an F-11F Tiger at speeds from 60 to 430 knots and at altitudes from sea level to 30 ft. was shown on film. The majority of accidents, Mr. Marciniak pointed out, occur during take-off and landing.

▶ A filmed study of various bodies of revolution and airfoils at different angles of attack in the Princeton smoke tunnel was shown at the October 8 meeting. The first issue of "Sonic," a joint IAS-ARS publication, was distributed at the close of the meeting.

▶ New officers for the school year, introduced at the October 1 meeting, are: Ira Cohen, Chairman; Thomas Lardner, Vice-Chairman; George Siebert, Treasurer; Donald Mackenzie, Corresponding Secretary; and Paul Shaff, Recording Secretary.

PAUL H. SHAFF
Recording Secretary

Princeton University

Professor Martin Summerfield gave a talk on "Earth Satellites" at the October 30 meeting. He traced the history of multistage rockets and discussed current rockets and earth satellites. The talk also dealt with the launching of rockets.

Professor Summerfield concluded with a slide showing comparative burnout velocities of three-stage rockets, their altitudes, gross weights, and payloads.

JAMES S. MCDONNELL, III
Secretary

Rensselaer Polytechnic Institute

This school's IAS Branch was joined by its ASME counterpart on October 18 to hear Edgar M. Cortright discuss "Current Research Trends in Flight Propulsion." Mr. Cortright is Chief, 6 × 8 Supersonic Wind Tunnel, NACA Lewis Flight Propulsion Laboratory.

Mr. Cortright concluded with a description of NACA research projects, after which the audience of some 40 students engaged him in a question and answer session.

CHARLES KROMER, *Secretary-Treasurer*

Stanford University

Student members at the October 16 meeting heard Prof. Nicholas J. Hoff, Chairman of the Aeronautical Engineering Department, speak on the advantages of membership in the IAS.

Two short films—*Beat the Heat*, an NACA film on structural effects of high-speed aerodynamic heating, and a Lockheed Missile Development Laboratories report on their X-7 and X-17 research vehicles—were shown.

New officers are Dale Compton, Chairman; Nick Vojvodich, Vice-Chairman; and Jack Dreyfus, Secretary-Treasurer.

JACK M. DREYFUS, *Secretary*

Syracuse University

On November 21 Salaman Eskinazi, Associate Professor, Mechanical Engineering, gave a talk entitled "Engineering Problems in Human Physiology."

Using schematic diagrams, Dr. Eskinazi described the human heart and blood system, to which he devoted most of his talk. Dr. Eskinazi said engineering in human physiology is one of the lesser known but challenging fields of engineering.

ELGIE C. RATH, JR.
Corresponding Secretary

Tri-State College

Officers for the winter term elected on November 22 were Donald Zurfluh, Chairman; Jack Ebersol, Vice-Chairman; Robert Spalding, Secretary; William Dillinger, Treasurer; and John Geisler, Student Council Representative.

Later, an NACA film, *Research for Tomorrow's Aircraft*, depicting flight and tunnel tests on high-speed aircraft, was shown.

Two films shown at the November 7 meeting were *Faster Than You Think*, about ingestion testing an axial flow jet engine, and *Magnesium*, showing how the metal is extracted from the sea.

▶ A film, *Design and Testing of Supersonic Flutter Models*, was shown at the October 24 meeting. The design and construction technique for supersonic flutter models were depicted. Lent by the Massachusetts Institute of Technology, the film also showed vibration and static testing procedure.

▶ George Sink and R. E. Martin of Convair discussed opportunities for engineers at their firm at the October 10 meeting.

Two films shown at this meeting were *Ames Aeronautical Laboratory in Action* and *Horizon Unlimited*. Wind tunnels at Ames and means of testing models were the subject of the first film. The second film told the story of The Martin Company's Viking rockets.

WILLIAM F. BERG, *Secretary*

University of Alabama

On October 3 Charles Brown, Project Engineer, KB-50, and Ernest Sims, Chief Administration Engineer, Hayes Aircraft Corporation, presented a film on *Air Strike Force*. The film depicted the KB-50's part in an Air Force mission which started in Texas and ended in Europe.

Mr. Brown discussed the many problems encountered in modification of the KB-50: wing tip vortices which interfered with the drogues of the tanker, electrical power, and structural fatigue problems.

WILLIAM F. BRITT, *Secretary*

University of Colorado

Student members at the November 7 meeting heard an address on the "Fatigue Testing of Aircraft Wings" by W. E. Weiss, Convair, San Diego. Mr. Weiss illustrated his address with a movie, *Full-Scale Wing Fatigue Testing*, which showed actual fatigue tests performed by Convair.

A second movie, *The New Sort of Freedom*, also was shown. This described the air defense operations which are performed from the time an unidentified aircraft is spotted until it is identified.

University of Kentucky

On November 21, student members were guests of the U.S. Air Force Filter Center in Lexington, Ky.

Lieutenant J. Clark, Operations Officer, explained the functions of the Filter Center in connection with the Ground Observers Corps. He pointed out that some 300 volunteers in the Lexington area have been trained in teams for plotting and analyzing information received from trained Ground Observers in specially located lookouts through Kentucky and parts of Ohio, Indiana, and Illinois.

A. L. WITTWER, *Secretary*

University of Notre Dame

Student members heard an address by Frank N. M. Brown at the October meeting. Mr. Brown is the Dean of Aeronautical Engineering at Notre Dame. His talk dealt with the organization and history of the Aeronautical Engineering Department.

WILLIAM B. MAGUIRE, *Secretary*

University of Pittsburgh

James Fligg, of Pratt & Whitney Aircraft, spoke about aircraft propulsion with emphasis on the development of the J-57 turbojet engine at the October 24 meeting.

Mr. Fligg explained how the piston, turbojet, turboprop, ducted fan, ram-jet, and rocket engines develop their thrust from

the velocity of the mass of air flowing through them.

Two of the biggest problems encountered in developing the J-57 turbojet engine, according to Mr. Fligg, were the high compression ratio needed and the flutter of compressor and turbine blades. The problem of high compression ratio was solved with the development of the axial flow split compressor. The use of shrouded turbine and compressor blades eased the flutter problem.

ROBERT F. GUSKY
Recording Secretary

University of Texas

More than 100 members met on October 28 to see a film, *Progress Report on the B-58*, presented by Harold T. Johnson, Project Structures Engineer at Convair, Fort Worth. The film followed the first B-58 through the various stages of production and testing.

▶ On October 14, H. Norman Abramson, Manager, Engineering Analysis, Department of Engineering Mechanics, Southwest Research Institute, spoke on airplane dynamics and flutter characteristics at high and low speeds and the work carried on at the Southwest Research Institute.

VERNON H. MALONE, JR.
Corresponding Secretary

University of Tulsa

Ed Brown, Director of Engineering Personnel, Douglas Aircraft Company, Tulsa, Okla., addressed a meeting on November 21. In his talk "Your Future in the Aircraft Industry," he outined four major engineering fields: "theoretician" who does "research for the sake of research"; "applied researcher" whose research is aimed to aid in the design of a particular product; "applied engineer" who is employed by the airframe or component manufacturer; and "engineer in management."

Mr. Brown noted that grade averages are becoming more important in finding the best jobs and that more emphasis will be put on advanced degrees.

KENNETH ROGER, *Secretary*

University of West Virginia

At the second meeting of the year on November 6, two motion pictures were shown—*Test Flight of the F-86* and *Tactical Use of Day Fighters and Fighter Bomber Operations*.

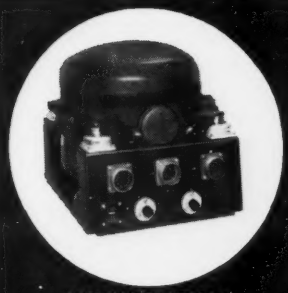
Tom Nale, a jet pilot and aeronautical engineering student at the University, answered questions concerning these two movies.

Professor Leon Z. Seltzer, guest speaker at the October meeting, outlined the Combined Contact-Instrument Primary Flight Training Research Project which was sponsored by the Link Foundation. He said that this method of instruction will help to reduce the number of serious or fatal aircraft accidents which occur when the private pilot inadvertently finds himself in instrument weather conditions.

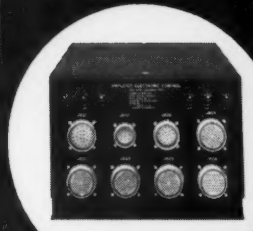
JACK H. HUNTER, *Secretary*

(*Continued on page 117*)

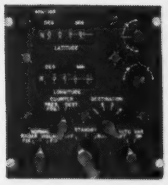
INERTIAL GUIDANCE SYSTEMS IN PRODUCTION



INERTIAL PLATFORM
Lightweight and compact, Kearfott four gimbal inertial platforms are characterized by rapid warm-up and alignment. Suitable for manned aircraft or missile applications.

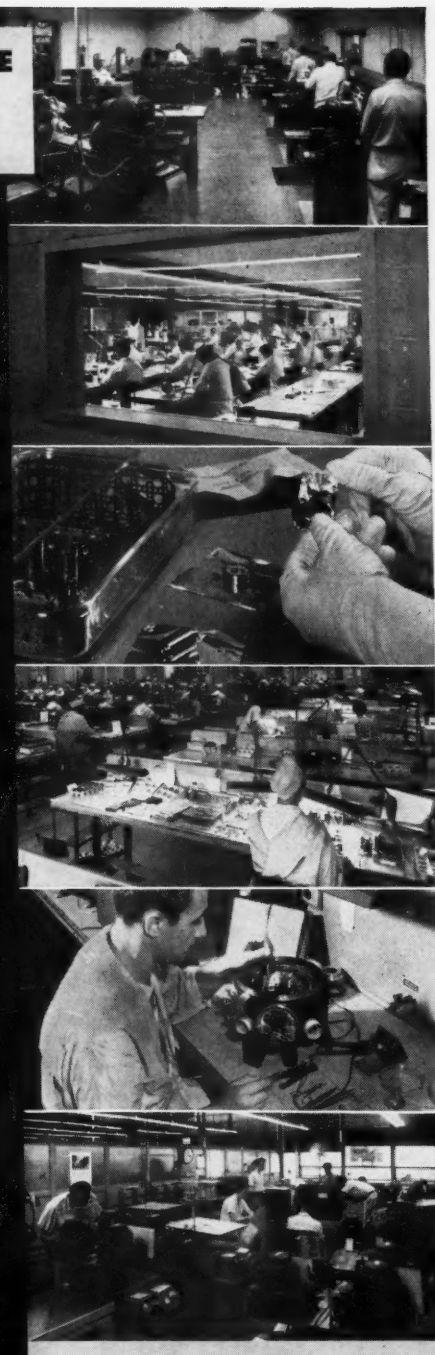


COMPUTER-AMPLIFIER
For analog or digital data processing. Available with fully transistorized amplifier modules.



PANEL
Display and control panel for pilot reference or ground support equipment.

Other Kearfott systems feature 18-pound, all attitude platforms with 2 minute warm-up time. Examples of compass systems are conventional or roll stabilized directional gyros and all attitude platforms with 0.25°/hour maximum drift rates.



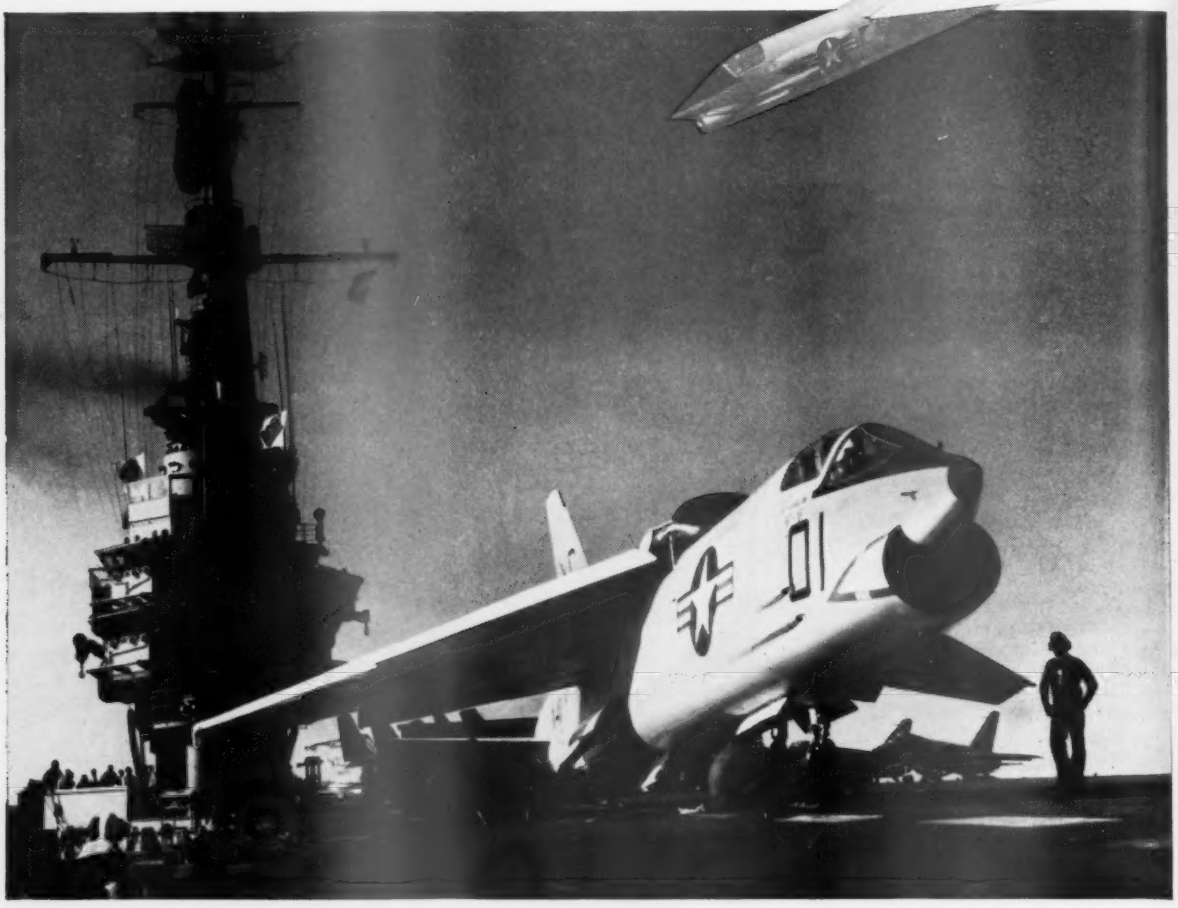
KEARFOTT COMPANY, INC.
LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J. Midwest Office: 23 W. Calendar Ave., La Grange, Illinois. South Central Office: 6211 Denton Drive, Dallas, Texas. West Coast Office: 253 N. Vinedo Avenue, Pasadena, California.

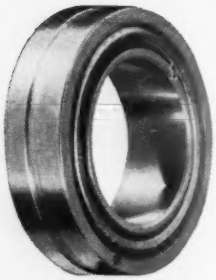
Kearfott

GENERAL PRECISION EQUIPMENT CORPORATION GPE

FIRST 1000 M.P.H. CARRIER-BASED FIGHTER



JOINS THE FLEET



Continuing a four-decade tradition of "firsts" in naval aviation, Chance Vought delivers the first 1000 plus m.p.h. aircraft for duty with the fleet—the F8U-1 Crusader.

As in most aviation firsts, Shafer Aircraft Bearing performance makes a vital contribution. In the Crusader, that performance is ample bearing capacity in higher than normal temperature ranges at key points in control systems.

Advanced Shafer research in bearing design and materials can make an important difference in your plans for the future. Take the first step today: write for Catalog 54. Shafer Bearing Division, CHAIN Belt Company, 801 Burlington Ave., Downers Grove, Ill.

SHAFER®

BEARING DIVISION
CHAIN BELT COMPANY

Aeronautical Reviews

A Guide to the Current Literature of Aeronautical Research and Engineering

THIS SECTION reviews important periodicals, technical and research reports, and books received in the IAS Library in order to provide basic documentation for engineers and scientists.

INTERNATIONAL AERONAUTICAL ABSTRACTS, published as an insert in each issue, is an accelerated reviewing service covering worldwide scientific and technical literature. This work is performed by the IAS Staff and is supported by the Air Force Office of Scientific Research of the Air Research and Development Command.

A list of the periodicals and reports series received in the IAS Library is published semiannually, in the January and July issues.

The AERONAUTICAL ENGINEERING INDEX, published since 1947, provides an annual cumulation of the materials reviewed in this section.

THE IAS LIBRARY

Publications reviewed in this section are maintained by the Library for use by the IAS Membership. They are *not* for sale but are made available through the facilities of the Library.

LENDING SERVICES: Institute members, both Individual and Corporate, may borrow periodicals, reports, and books for a period of 2 weeks, excluding time in transit. Excepted are certain reference books and those IAS publications that may be purchased.

PHOTOCOPY SERVICES: The Library is equipped to provide, as a service, positive photocopies of certain materials in its collections. Rates on request.

For detailed information about these and other services, write to:

John J. Glennon, Librarian
Institute of the
Aeronautical Sciences, Inc.
2 East 64th Street
New York 21, New York

PERIODICALS AND REPORTS 72

INTERNATIONAL AERONAUTICAL ABSTRACTS. 75

BOOKS 115

Subject Index to Periodicals & Reports

Acoustics, Sound, & Noise 72
Aerodynamics 72
  Aerothermodynamics 72
  Boundary Layer 72
  Fluid Mechanics & Aerodynamic Theory 72
  Internal Flow 72
  Natural Flight 72
  Stability & Control 91
  Wings & Airfoils 91
Aeroelasticity 91
Aeronautics, General 91
Airplane Design 91
  Air Conditioning & Pressurization 92
  Cockpits 92
  Landing Gear 92
  Windshields 92
Airports 92
Aviation Medicine 92
Computers 92
Education & Training 92
Electronics 92
  Amplifiers 94
  Antennas 94
  Circuits & Components 94
  Communications 94
  Construction Techniques 94
  Cooling 94
  Electronic Tubes 96
  Measurements & Testing 96
  Oscillators & Signal Generators 96
  Power Supplies 96
  Semiconductors 96
  Telemetry 96
  Wave Propagation 96
Equipment 96
  Electric 96
  Hydraulic & Pneumatic 96
Flight Testing 96
Fuels & Lubricants 96
Gliders 96
Ice Formation & Prevention 96
Instruments 96
  Automatic Control 96
  Flow Measuring Devices 99
  Temperature Measuring Devices 99
  Vibration Measuring Devices 99
Laws & Regulations 99
Machine Elements 100
Maintenance 100
Materials 100
  Corrosion & Protective Coatings 100
  Metals & Alloys 100
  Metals & Alloys, Nonferrous 100
  Nonmetallic Materials 100
  Testing 100
Mathematics 100
Mechanics 104
Meteorology 104
Military Aviation & Armament 105
Missiles 105
Navigation 106
  Electronic Aids 106
Nuclear Energy 106
Photography 106
Physics 106
Power Plants 106
  Jet & Turbine 106
  Rocket 106
Production
  Metalworking 106
  Nonmetalworking 106
  Production Engineering 106
  Tooling 108
  Welding 108
Rocket Sleds 108
Rotating Wing Aircraft 108
Space Travel 108
Structures 110
  Bars & Rods 110
  Cylinders & Shells 110
  Elasticity & Plasticity 112
  Plates 112
  Sandwich Structures 112
  Testing 112
  Thermal Stress 112
  Weight Analysis & Control 112
  Wings 112
Thermodynamics 112
  Heat Transfer 112
VTOL & STOL 112
Water-Borne Aircraft 112
Wind Tunnels & Research Facilities 112

XUM

Acoustics, Sound, & Noise

Noise—Some Implications for Aviation. K. K. Neely. (*CAI Annual Gen. Meeting, Ottawa, May 27, 28, 1957, Preprint 7/8.*) *Can. Aero. J.*, Nov., 1957, pp. 312–317. Outline of suggestions to aid airport operators in attenuating and controlling high intensity noise.

Diffraktsiia Zvuka na Tonkoi Ogranichennoi Uprugoi Tsilindricheskoi Obolochke. L. M. Liamshev. *AN SSSR Dokl.*, July 11, 1957, pp. 271–273. 11 refs. In Russian. Study of the sound diffraction on a thin elastic bounded cylindrical shell.

DC-8's and Decibels. F. B. Greatrex. *Air BP*, No. 5, 1957, pp. 32–36. Elemental discussion of the subject of jet noise and its reduction, with special material on the Comet IV and the DC-8 and Boeing 707.

Ob Istochnikakh Energii pri Termicheskom Vozbuzhdenii Zvuka. B. V. Raushenbakh. *AN SSSR Dokl.*, July 11, 1957, pp. 256–258. In Russian. Discussion of energy sources in the thermal excitation of sound.

A Note on the Reflection of Sound Waves at an Oblique Shock. C. T. Chang. *J. Aero. Sci.*, Jan., 1958, pp. 70, 71. OSR-ONR-OOR sponsored examination of the nature of reflected sound waves, and determination of the reflection coefficient.

Ob Odnom Tochnom Reshenii Uravnenii Akustiki. O. S. Ryzhov. *Prikl. Mat. i Mekh.*, May-June, 1957, pp. 434–437. In Russian. Derivation of an exact solution of acoustic-wave equations.

Aerodynamics

Aerodynamic Studies: The Forces Acting on an Air Vehicle; A Review of the Literature. M. Z. Krzywoblocki. *USAF WADC TN 56-360, Pt. XVI*, May, 1957. 90 pp. 446 refs. Bibliography discussing briefly papers and reports considered to be of most interest to the aerodynamicist.

Aerothermodynamics

A Survey of Heat Transfer Problems Encountered by Hypersonic Aircraft. Jackson R. Stalder. (*ARS Semi-Annual Meeting, San Francisco, June 10–13, 1957.*) *Jet Propulsion*, Nov., 1957, pp. 1,178–1,184. 33 refs. Discussion of aerothermodynamic problems as applied to an aircraft which is boosted to high speed and altitude by a rocket engine and then utilizes its kinetic and potential energy to glide to its destination.

Calculation of Local Heat-Transfer Coefficients on Slender Surfaces of Revolution by the Mangler Transformation. Shao-Yen Ko. *J. Aero. Sci.*, Jan., 1958, pp. 62, 63. Application of the Mangler transformation to evaluate local heat transfer for the case of laminar heat transfer from semi-ellipsoidal surface of fineness ratio four.

Mass Transfer Cooling at Mach Number 4.8. B. M. Leadon, C. J. Scott, and G. E. Anderson. *J. Aero. Sci.*, Jan., 1958, pp. 67, 68. OSR-sponsored results of mass-transfer experiments on a 5 mil wire porous cone of 20° total angle using air and helium injection.

Boundary Layer

Prostranstvennyi Laminarnyi Pogranichnyi Sloi na Beskonechnom Krugovom Sektore. L. G. Naumova. *Prikl. Mat. i Mekh.*, 1957, pp. 478–485. In Russian. Derivation of an approximate solution of the problem of motion in a laminar boundary layer produced on an infinite circular sector in the case of an external potential flow corresponding to a rectilinear vortex normal to the sector plane. Methods derived by Loos, Cooke, and Mager are taken into account.

Boundary-Layer Slip Solutions for a Flat Plate. Hidenori Hasimoto. *J. Aero. Sci.*, Jan., 1958, pp. 68, 69. Solutions of boundary-layer equations using von Mises transformation.

Neuere theoretische Untersuchungen über den Strahlflügel in zweidimensionaler Strömung. Willi Jacobs. *ZFW*, Sept., 1957, pp. 253–259. 24 refs. In German. Survey of recent theoretical investigations of jet-flapped wings in two-dimensional flow. A method is developed in which a curved flap approximates the real path of the jet stream.

Skewed Boundary-Layer Flow Near the End Walls of a Compressor Cascade. Appendix—**Description of Cascade and Instrumentation.** R. W. Moore, Jr., and D. L. Richardson. (*ASME Annual Meeting, New York, Nov. 25–30, 1956.*) ASME Trans., Nov., 1957, pp. 1,789–1,800. Illustration of the importance of the crossflow in determining boundary-layer growth by estimating the values of terms in the momentum integral equation in the free-stream direction. This estimate is based upon measurements of boundary-layer flow.

An Investigation of the End-Wall Boundary Layer of a Turbine-Nozzle Cascade. J. R. Turner. (*ASME Annual Meeting, New York, Nov. 25–30, 1956.*) *ASME Trans.*, Nov., 1957, pp. 1,801–1,806. Investigation leading to the conclusion that (a) the end-wall boundary-layer behavior inside the nozzle passage is essentially independent of the boundary layer entering the cascade; and that (b) the low-energy fluid in the suction-surface end-wall corner at cascade discharge has its origin only in the end wall and suction-surface boundary layers.

O Razvitii Techeniia Viazkoi Zhidkosti Mezhdu Parallel'nymi Poristymi Stenkami. N. A. Slezkin. *Prikl. Mat. i Mekh.*, 1957, pp. 591–593. In Russian. Study of the problem of the flow development between two parallel porous surfaces using the method of operational calculus.

Application of Görtler's Series Method to the Boundary-Layer Energy Equation. E. M. Sparrow. *J. Aero. Sci.*, Jan., 1958, pp. 71, 72. Solutions for a heat-transfer problem for a two-dimensional body with variable free-stream velocity. Numerical results are shown for heat transfer from a symmetrical body with a stagnation point for Prandtl Number, Pr = 1.

Nekotorye Sluchai Avtomodel'nykh Dvizhenii Neszhimaemoi Zhidkosti v Nestatsionarnom Laminarnom Pogranichnom Sloe. L. A. Rozin. *Prikl. Mat. i Mekh.*, May-June, 1957, pp. 361–367. In Russian. Study of the motion of an incompressible fluid in a nonstationary laminar boundary layer. Includes cases where the solution of boundary-layer equations can be reduced to the integration of ordinary differential equations.

Formirovanie Pogranichnogo Sloia na Plastinke Dvizhushchimsia Skachkom Uplotneniia. Iu. A. Dem'ianov. *Prikl. Mat. i Mekh.*, May-June, 1957, pp. 368–374. In Russian. Investigation of the boundary-layer formation on a plate with a moving compression wave.

Fluid Mechanics & Aerodynamic Theory

Nekotorye Tochnye Resheniia Uravnenii Odnomernogo Neustanovivshegosia Dvizheniia Sovershennogo Gaza. N. N. Kochina. *Prikl. Mat. i Mekh.*, 1957, pp. 449–458. In Russian. Derivation of exact solutions for the equations of unidimensional unsteady motion of an ideal gas.

On the Stream Functions in Nonsteady Three-Dimensional Flow. M. Z. v. Krzywoblocki. *J. Aero. Sci.*, Jan., 1958, p. 67.

Nonuniform Rotation of an Infinite Circular Cylinder in an Infinite Viscous Liquid. D. D. Mallick. *ZAMM*, Sept.-Oct., 1957, pp. 385–392. Derivation of rigorous solutions giving the initial unsteady motion produced by the rotation of a circular cylinder in a viscous liquid. Solutions are obtained for the liquid outside or inside the rotating cylinder, and in every case a steady state is reached.

Note on the Position of Ring Singularities in an Axisymmetric Potential Field. N. T. Bloomer. *J. Fluid Mech.*, Nov., 1957, pp. 217–220. Establishment of a method for finding the position by consideration of the much easier case of a similar two-dimensional potential function.

A Principle of Virtual Displacements for Real Fluids. Paul Lieber, Koon-Sang Wan, and Olaf Anderson. (*Appl. Mech., 9th Internatl. Congress, Brussels, Sept., 1956.*) *Rensselaer Polytech. Inst. Dept. Geol. Rep.* (*AFOSR TN 57-476*) [*AD 136468*], July, 1957. 21 pp. Presentation of a principle of virtual displacements for incompressible viscous flows by which the Euler conditions become the Navier-Stokes equations for a Newtonian fluid.

A New Method of Energy Exchange Between Flows and Some of Its Applications. J. V. Foa. *Rensselaer Polytech. Inst., Dept. Aero. Eng. TR AE5509*, Dec., 1955. 50 pp. Analysis of a flow process in which the pressure field is generated by the collision of two steady flows, and is utilized as the vehicle for the transfer of energy from one of the two flows to the other. Some applications are described for purposes of illustration.

New Air for Engineers. Joseph G. Logan, Jr. *Missiles & Rockets*, Nov., 1957, pp. 86, 88, 90. Discussion of air properties based upon the fact that in the regime between Mach Numbers of 6 and 30 (the "hypersonic" regime) the ideal gas concept of air must be abandoned.

A Principle of Minimum Dissipation for Real Fluids. Paul Lieber and Koon-Sang Wan. (*Appl. Mech. 9th Internatl. Congress, Brussels, Sept., 1956.*) *Rensselaer Polytech. Inst. Dept. Geol. Rep.* (*AFOSR TN 57-477*) [*AD 136469*], Aug., 1957. 51 pp. Analysis suggesting that the minimization of dissipation can be achieved in two ways: by minimizing the modulus of the resultant force or by increasing the angle between the resultant force and the velocity vector so that it approaches $\pm \pi/2$.

O Techeniiakh s Vyrozhdennym Godografom. O. S. Ryzhov. *Prikl. Mat. i Mekh.*, 1957, pp. 564–568. In Russian. Study of the relation existing between two types of three-dimensional gas flows expressed by a curve or a surface in the hodograph plane and the theory of characteristic differential equations in hyperbolic derivatives.

Kosoi Udar Dvumernoi Strui Gaza v Ploskuiu Stenku. A. I. Nazarov. *Prikl. Mat. i Mekh.*, May-June, 1957, pp. 431–433. In Russian. Study of the problem of a two-dimensional gas stream striking obliquely a flat infinite surface for the case where the velocity of the stream at infinity forms an angle θ_0 with the surface.

Wave Propagation in a Heterogeneous Elastic Medium. A. Robinson. *J. Math. & Phys.*, Oct., 1957, pp. 210–222. Analysis of a problem previously considered by Jeffreys. It is assumed that a wave possesses a discontinuity of some sort across a wave front. A system of ordinary differential equations is developed to satisfy the discontinuity along the rays.

On the Generation of Surface Waves by Shear Flows. John W. Miles. *J. Fluid Mech.*, Nov., 1957, pp. 185–204. 27 refs. Development of a generation mechanism on the basis of the inviscid Orr-Sommerfeld equation. Results are applicable to flutter of membranes and panels.

Application de l'Interférométrie à l'Etude de l'Ecoulement d'un Fluide Visqueux en Aval d'une Onde de Choc Détachée. Paul Guienne and Fernand Bouniol. *La Recherche Aéronautique*, Sept.-Oct., 1957, pp. 13–18. In French. Application of interferometry to the study of flow of a viscous fluid downstream of a detached shock wave in the leading edge region of a profile at $M_0 = 1.96$.

Supersonic Flow Around Blunt Bodies. Hyman Serbin. *J. Aero. Sci.*, Jan., 1958, pp. 58, 59. Method of determining shock detachment distance, shock shape, streamlines, and velocities in terms of the density ratio across the normal shock. Results are shown for spheres and discs.

Incompressible Potential Flow About Axially Symmetric Bodies in Ducts. Philip Levine. (*USAF WADC TN 57-287*, Aug., 1957). *J. Aero. Sci.*, Jan., 1958, pp. 33–36.

Hypersonic Flow Around a Sphere. R. D. Linnell. *J. Aero. Sci.*, Jan., 1958, pp. 65, 66. Method of estimating the stagnation-point surface-velocity gradient and the axial shock detachment distance for hypersonic flow around a sphere, taking into account real gas effects.

Zamechanie o Linearizatsii Uravnenii Gazovoi Dinamiki. M. L. Gurevich and M. D. Khaskind. *Prikl. Mat. i Mekh.*, May-June, 1957 pp. 437, 438. In Russian. Derivation of a solution for the problem of a plane subsonic flow of nonviscous gas around an infinite plate.

Raschet Nekotorykh Zvukhovykh Techenii Gaza. P. I. Chushkin. *Prikl. Mat i Mekh.*, May-June, 1957, pp. 353–360. 10 refs. In Russian. Application of an approximate method to the problem of symmetric sonic gas flow around the nose of an ellipse or an ellipsoid of revolution and extension to the case of an arbitrary profile.

Ob Ustoichivosti Ploskoi Statsionarnoi Udarnoi Volny. S. V. Iordanskii. *Prikl. Mat. i Mekh.*, 1957, pp. 465–472. In Russian. Study of the stability of a plane stationary shock wave, with derivation of differential equations for the pressure disturbance and boundary conditions, of equations for the disturbance of the shock-wave surface, of stability conditions, and the asymptotic law governing the turbulence attenuation for the case of a gas extending at infinity behind the shock wave.

A Simple Graphical Method for Constructing Two-Dimensional Supersonic Flows by Means of a Drafting Machine. F. Edward Ehlers. *J. Aero. Sci.*, Jan., 1958, pp. 69, 70. Presentation of a simplification of the Puckett field method of characteristics for supersonic flows. By means of special tables, a Mach net can be constructed using a drafting machine without any intermediate calculation.

Über die Geschwindigkeitsverteilung in Wirbeln. A. Timme. *Ing.-Arch.*, No. 4, 1957, pp. 205–225. 14 refs. In German. Investigation of the velocity distribution in vortices, and theoretical examination of special flow problems with vortices, e.g., the von Kármán vortex street.

Internal Flow

Zur Berechnung der Strömung durch axiale Schaufelgitter. Wolfgang-Hermann Isay. *ZAMM*, Sept.–Oct., 1957, pp. 321–335. In German. Presentation of numerical examples to illustrate and further develop a previously established theory.

Zweiparametrige Ordnung der ebenen Gitter nach ihrer Wirkung im Grossen mit einer Anwendung auf Hochgeschwindigkeitsgitter. P. Ruden. *France, ONERA, J.I.S.A., Paris, May 27–29, 1957, Comptes Rendus, Pt. 2*, pp. 51–68. In German. Investigation of the bidimensional straight cascade problem for incompressible potential flow, based on two parameters. Includes application to high-speed cascades.

Experimental Investigation of the Rotating Stall in a Single-Stage Axial Compressor. Jacques Valensi. (*IAS 25th Annual Meeting, New York, Jan. 28–31, 1957, Preprint 700.*) *J. Aero. Sci.*, Jan., 1958, pp. 1–10, 72. 14 refs.

Boundary-Layer Correction in Supersonic Nozzle Scaling. Abraham Kogan. *J. Aero. Sci.*, Jan., 1958, p. 64. Analysis showing that when a nozzle is developed from a given protype by geometrical scaling of the perfect-fluid-flow wall streamline, the boundary-layer correction may be calculated to a fair approximation by proportion from the prototype boundary-layer correction.

Some Investigations of the Hydrodynamics of Jets of Liquid Issuing from a Nozzle at Pressures up to 1500 Atmospheres. L. F. Vereshchagin, A. A. Semerchan, A. I. Firsov, V. A. Galaktionov, and F. M. Filler. *Sov. Phys.-Tech. Phys.*, No. 11, 1957, pp. 2,484–2,490. Study of high pressure jets which indicates that even at velocities of the order of 500 m/sec. the jets remain compact. Close to the velocity of sound in air, disturbances appear. The length of standing waves along a jet increases with the velocity and the disturbances disappear.

Natural Flight

Aspects of Insect Flight. Brian Hocking. *Sci. Mo.*, Nov., 1957, pp. 237–244. 24 refs.

(*Continued on page 91*)

XUM

INTERNATIONAL AERONAUTICAL ABSTRACTS

A Review of Worldwide Scientific and Technical Literature

Selected and prepared by the IAS Staff from currently released material received in the IAS Library. This research was supported in whole or in part by the Air Force Office of Scientific Research, Air Research and Development Command, United States Air Force.

The literature abstracted in this section is available through the lending or photocopying services of the IAS Library, New York.

PUBLISHED MONTHLY BY THE AERONAUTICAL ENGINEERING REVIEW

Official Publication of the Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

Volume 3, Number 2 February, 1958

ACOUSTICS, SOUND, & NOISE

METHODS FOR ESTIMATING DISTRIBUTIONS AND INTENSITIES OF SONIC BANGS. Appendix - THE PROPAGATION OF SONIC BANGS IN A NON-HOMOGENEOUS ATMOSPHERE. D. G. Randall. Gt. Brit., RAE TN Aero. 2524, Aug., 1957. 53 pp. Application of the developed methods to several flight maneuvers and discussion of the results. The effect on sonic bang distributions and intensities of refraction (caused by the temperature gradient existing in the actual atmosphere) is also discussed.

NOISE MEASUREMENTS ON COLD JETS USING CONVERGENT-DIVERGENT NOZZLES. R. E. Franklin. Aero. Quart., Nov., 1957, pp. 346-359. Comparison of the results with those from a test on a convergent nozzle. At the design pressure ratio, reductions in the noise were found, particularly at 90° to the jet direction. For lower forward pressures the noise is also less, but above the design pressure the noise rises rapidly to the same level as that with a convergent nozzle. Results are applicable in certain respects to hot jets.

AERODYNAMICS

Aerothermodynamics

LAMINAR BOUNDARY LAYER WITH HEAT TRANSFER ON A CONE AT ANGLE OF ATTACK IN A SUPERSONIC STREAM. Appendix A, B - HEAT TRANSFER AND RECOVERY FACTOR FOR PRANDTL NUMBER DIFFERENT FROM 1.0. Appendix C - EXTENSION OF PRESENT SOLUTIONS TO VERY LARGE ANGLE OF ATTACK USING YAWED INFINITE CYLINDER RESULTS. Eli Reshotko. US, NACA TN 4152, Dec., 1957. 64 pp. 12 refs. Derivation of equations for the compressible laminar boundary layer for the windward streamline in the plane of symmetry of a yawed cone. Solutions are obtained for both insulated and cooled surfaces. The heat-transfer rate to this most windward streamline increases significantly with angle of attack. For a surface cooled to absolute zero temperature, the relative increase with angle of attack is about 15% less than for an almost insulated surface. A supplementary calculation shows the heat transfer to vary with the Prandtl Number Pr approximately as $Pr^{0.37}$, while the recovery factor is well estimated by the square root of the Prandtl Number.

APPROXIMATE CALCULATION OF THE COMPRESSIBLE TURBULENT BOUNDARY LAYER WITH HEAT TRANSFER AND ARBITRARY PRESSURE GRADIENT. Appendix A, B - DERIVATION OF TRANSFORMED BOUNDARY-LAYER INTEGRAL EQUATIONS. Appendix C - ADAPTATION OF LUDWIEG-TILLMANN TURBULENT SKIN-FRICTION RELATION TO COMPRESSIBLE FLOW. Appendix D - FURTHER INTEGRATION OF MOMENTUM INTEGRAL EQUATION. Eli Reshotko and Maurice Tucker. US, NACA TN 4154, Dec., 1957. 34 pp. 19 refs. Presentation of a method which involves the momentum integral and moment-of-momentum equations as simplified by the use of Stewartson's transformation. The Ludwieg-Tillmann skin-friction relation is used in three equations in a form suitable for compressible flow with heat transfer through application of the reference enthalpy concept. A tentative extension of Reynolds analogy is suggested for estimating heat-transfer effects.

THE HECKER METHOD OF TRANSIENT TEMPERATURE CALCULATION. A. W. Trimpi. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 774. 15 pp. Members, $0.50; nonmembers, $0.85. Description of an approximate method, based on a continuous (not lumped) time concept, for the application to interior structural elements. The method is capable of handling the influence of colder as well as hotter elements,

simple cases, as well as cases of reasonable complexity, such as those involving temperature-varying thermal conductivities and specific heats, and involves only simple addition, substraction, and multiplication. Different applications are outlined.

STAGNATION POINT HEAT-TRANSFER MEASUREMENTS IN DISSOCIATED AIR. P. H. Rose and W. I. Stark. J. Aero. Sci., Feb., 1958, pp. 86-97. 21 refs. USAF-sponsored presentation of shock tube results for the laminar heat transfer at the stagnation point of a blunt body in partially dissociated air, and comparison to theoretical treatment of Fay and Riddell. Heat-transfer results are also presented for air temperatures up to 8,000°K where more than 50 per cent of the molecules are in the dissociated state. It is shown that simulation of flight stagnation conditions at velocities up to satellite velocity of 26,000 ft./sec. is possible in shock tubes, and data can be obtained over a large altitude range at these velocities.

THEORY OF STAGNATION-POINT HEAT TRANSFER IN DISSOCIATED AIR. J. A. Fay and F. R. Riddell. J. Aero. Sci., Feb., 1958, pp. 73-85. 11 refs. USAF-sponsored development of the boundary-layer equations for very high speed flight (dissociated state of external flow), including the effects of diffusion and of atom recombination. The stagnation point equations can be reduced to a set of nonlinear ordinary differential equations, and two methods of numerical solution are presented, one for the equilibrium case, and the other for the nonequilibrium case. The study includes correlation of numerical results, representation of solutions, and the conclusion that heat transfer through the equilibrium stagnation point boundary layer can be computed accurately by a simple correlation formula, being almost unaffected by a nonequilibrium state, provided the wall is catalytic and the Lewis Number near unity.

EVALUATION OF SEVERAL HYPERSONIC TURBULENT HEAT TRANSFER ANALYSES BY COMPARISON WITH EXPERIMENTAL DATA. P. A. Libby. Polytech. Inst. Bklyn., Dept. Aero. Eng. & Appl. Mech., PIBAL WADC TN 57-72 [AD118093], July, 1957. 37 pp. 15 refs. Measurements of laminar, transitional, and turbulent heat transfer by means of the shrouded model technique on a model consisting of a portion of a sphere. The pressure distribution gave an accelerating flow from the stagnation point to a local Mach Number of about 0.75. The enthalpy ratios varied from 2 to 1.4 and the Reynolds Number over a six-fold range. It is shown that the results are in reasonable agreement with experimental data.

MEASUREMENT OF TURBULENT HEAT TRANSFER RATES ON THE AFT PORTION AND BLUNT BASE OF A HEMISPHERE-CYLINDER IN THE SHOCK TUBE. Josef Rabinowicz. GALCIT Memo. 41, Nov. 1, 1957. 24 pp. 10 refs. Army-sponsored investigation to determine whether time-independent heat-transfer rates on a blunt base are established in the time interval available in the shock tube (about 400-600 microsec.); and to determine heat transfer rates on a blunt base when the body is supported from the side, in order to eliminate the usual disturbing effect of a rear sting support. The measured ratio on the cylindrical portion agreed well with previous flat plate measurements for small temperature differences, although the ratio of stagnation to surface enthalpy (h_s/h_w) varied between three to eight in the present tests. The measured heat transfer rate on the base indicates that at the center of the base, the heat transfer rate is comparable to that on the surface just ahead of the base, while the heat transfer rate falls off 1/2 to 1/3 of this value towards the rim of the base.

APPROXIMATE THREE-DIMENSIONAL SOLUTIONS FOR TRANSIENT TEMPERATURE DISTRIBUTION IN SHELLS OF REVOLUTION. M. A. Brull and J. R. Vinson. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 775. 17 pp. Members, $0.50; nonmembers, $0.85. Derivation, by means of suitable approximations based on geometric considerations, of a simplified heat conduction equation for shells of revolution. The equation is separable for all shapes of shells and leads to analytical solutions in terms of classical functions. It is shown that the transient temperature solution for a shell of revolution may be obtained in the form of a sum or product of a slab solution and a correction function.

EFFECTS OF LEADING-EDGE BLUNTING ON THE LOCAL HEAT TRANSFER AND PRESSURE DISTRIBUTIONS OVER FLAT PLATES IN SUPERSONIC FLOW. Appendix A - DETERMINATION OF THE HEAT-TRANSFER AREA. Appendix B - LOCAL REYNOLDS NUMBERS. Appendix C - REFERENCE TEMPERATURE FOR FLUID PROPERTIES. M. O. Creager. US, NACA TN 4142, Dec., 1957. 54 pp. 21 refs. Surface pressure and heat-transfer rate measurements on flat plates with various values of blunting for a Mach Number of 4 and Reynolds Numbers per inch of 2380 and 6600. Surface pressures are correlated for a wide range of variables by a linear combination of terms obtained from shock-wave boundary-layer interaction theory and blast wave theory. A method is developed to correlate local Reynolds Numbers from the present data with data from other sources covering a wide range of test conditions.

Boundary Layer

BOUNDARY LAYER MEASUREMENTS ON 15° AND 24.5° CONES AT SMALL ANGLES OF INCIDENCE AT M = 3.17 AND 3.82 AND ZERO HEAT TRANSFER. F. V. Davies and R. J. Monaghan. Gt. Brit., RAE Rep. Aero. 2577, June, 1957. 40 pp. 14 refs. Presentation of results showing that the transition front is extremely sensitive to incidence, a fourfold variation occurring between transition Reynolds Numbers on the leeward and windward sides of the 15° cone at 2° incidence. At zero inci-

dence the transition Reynolds Number was between 2.5 and 3.0 x 10^6 and no significant variation was observed over the test range of stagnation pressures from 2 to 5 atmosphres.

VELOCITY AND FRICTION CHARACTERISTICS OF LAMINAR VISCOUS BOUNDARY-LAYER AND CHANNEL FLOW OVER SURFACES WITH EJECTION OR SUCTION. Appendix A, B - COMPARISON OF RESULTS WITH PREVIOUS INVESTIGATIONS. Appendix C - MODIFICATIONS REQUIRED AND EFFECT OF STEP SIZE IN NUMERICAL SOLUTIONS. E. R. G. Eckert, P. L. Donoughe, and B. J. Moore. US, NACA TN 4102, Dec., 1957. 57 pp. 24 refs. Development of dimensionless flow parameters common to both channel and boundary-layer flow to determine the extent to which the boundary conditions imposed on the flow by the various geometries influence the flow characteristics. These parameters are used to compare the various flows, the flow on surfaces with fluid ejection and on solid surfaces, and the results show that they depend on the local boundary-layer thickness, on the pressure gradient in the main-flow direction, and on the rates of ejection. This information is used for correlations and for calculations by integral methods.

Control Surfaces

FINS. J. Wolkovitch. RAeS J., Dec., 1957, pp. 815-818. Study of some principles on which fin design is based, and description of some of the difficulties. These include directional stability, choice of fin area and shape, inertial cross-coupling in roll, and aerodynamic aspects.

ANALYSIS OF HORIZONTAL-TAIL LOADS IN PITCHING MANEUVERS ON A FLEXIBLE SWEPT-WING JET BOMBER. W. S. Aiken, Jr. US, NACA TN 4191, Dec., 1957. 58 pp. 11 refs. Determination from flight maneuvers of the wing-fuselage aerodynamic-center position, zero-lift pitching-moment coefficient, airplane pitching moment of inertia, and radius of giration. A similar analysis is made of the time-history data for the elevator angles and the results are found to agree with those of the tail-load analysis. Details of the analysis procedures and the least-squares methods used are given.

THE AERODYNAMIC EFFECTS OF ASPECT RATIO ON CONTROL SURFACE FLUTTER. H. Hall and E. W. Chapple. Gt. Brit., RAE TN Struc. 227, Sept., 1957. 16 pp. Description of a series of low speed flutter tests to obtain a direct measurement of the aerodynamic effects of aspect ratio on wing-aileron flutter. Tests are made on rigid wings fitted with full span ailerons, the wings having root flexibilities in roll and pitch. Provisions are made for massbalancing the ailerons, and some general conclusions are drawn concerning the effects of aspect ratio and massbalance on control surface flutter.

Fluid Mechanics & Aerodynamic Theory

INCOMPRESSIBLE MIXING OF A SHEAR FLOW WITH FLUID AT REST. L. G. Napolitano. Polytech. Inst. Bklyn., Dept. Aero. Eng. & Appl. Mech., PIBAL Rep. 318 (AFOSR TN 57-754) [AD136743], Nov., 1957. 44 pp. 16 refs. Investigation of the laminar and turbulent mixing of a nonuniform free stream with the fluid at rest. Laminar and turbulent vorticity numbers are defined, which measure the relative importance of the free stream vorticity as compared to the average vorticity present in the wake. Results of the analysis can be assumed to apply to a stream having constant vorticity over a finite y-length. The results indicate that a stream with negative vorticity can considerably increase the rate of mixing, and that the effects are more pronounced in laminar than in turbulent flow and persist longer in the streamwise direction. It appears that the presence of vorticity in the outer stream can be a practical and efficient device to control the transfer of properties between two different streams.

HIGH SPEED MACHINE SOLUTIONS FOR PLANE TURBULENT HOMOGENEOUS AND NON-HOMOGENEOUS MIXING. L. G. Napolitano. Polytech. Inst. Bklyn., Dept. Aero. Eng. & Appl. Mech., PIBAL Rep. 399 (AFOSR TN 57-755) [AD136744], Oct., 1957. 37 pp. Presentation of numerical values for the total differential equation governing mixing for a parabolic variation of the density ratio with the velocity ratio. Each solution is identified by the values of three parameters characterizing flow properties and the nature of the free streams. A total of 28 cases is given, covering a wide range of parameters.

THE INSTABILITY OF A SHEAR LAYER BETWEEN TWO PARALLEL STREAMS. R. E. Esch. J. Fluid Mech., Dec., 1957, pp. 289-303. Investigation of an unbounded parallel flow consisting of a linear shear layer between uniform streams. A conventional eigenvalue problem is formulated and solved by both analytical and numerical methods. The region of instability in the plane of Reynolds Number R and disturbance wave number α is determined, and typical growth rates in the unstable region are computed. The extent to which the present results can be applied to laminar boundary layer between free streams is discussed.

THE MIXING OF UNBOUNDED COAXIAL COMPRESSIBLE STREAMS. D. R. Willis and Irvin Glassman. Jet Propulsion, Dec., 1957, pp. 1, 241-1, 248. 15 refs. ONR-supported investigation of the over-all characteristics, and experiments to determine the effects of the fundamental parameters (initial Mach Number and stagnation temperature ratio). Included were the primary Mach Numbers of 2.60, 0.97 and 0.68, the secondary Mach Numbers of 0.45, 0.25, and 0.00, and stagnation temperature ratios of 1.00 and 1.429. Mass flows and mixing rates are computed, and results show a very marked effect on the secondary Mach Number.

It is further shown that a practical correlation between the spreading rates exists for the subsonic Mach Numbers.

TRANSPORT PROCESSES BETWEEN FLUIDS AND CLOUDS OF SUSPENDED PARTICLES: SOME EXACT SOLUTIONS. D. B. Spalding. Royal Soc. (London) Proc. Ser. A, Nov., 1957, pp. 430-443. Analysis of a process which involves the burning of liquid fuel sprays, and takes into account convection and turbulent mixing of the cloud. The Eulerian equation of conservation for the steady process is shown to be transformable into the Fourier equation for unsteady heat transfer in a flowing medium. Exact solutions are given for a one-dimensional system, an axially symmetrical system, and the steady-flow homogeneous reactor. Numerical methods are indicated for more complex systems, and the possibility of solution by means of an analogue is pointed out.

FLOW ABOUT CONES AT VERY HIGH SPEEDS. H. K. Zienkiewicz. Aero. Quart., Nov., 1957, pp. 384-394. 10 refs. Study of the effects of vibrational excitation and dissociation of air on inviscid flows past a circular cone at zero incidence with an attached shock wave. Thermal equilibrium is assumed, and a numerical solution is outlined. For the flow between the surface of the cone and the shock wave an approximate analytical solution is developed. Includes two numerical illustrative examples which are compared with the corresponding solutions assuming constant air properties.

CALCULATION OF SUPERSONIC FLOW PAST SLOWLY OSCILLATING BODIES OF REVOLUTION BY USE OF ELECTRONIC COMPUTERS. Johann Muench. USAF OSR TN 57-673 [AD 136662], 1957. 21 pp. Methods, adapted to electronic computers, for the calculation of surface pressure and the quasi-steady and unsteady aerodynamic coefficients in oscillating bodies of revolution. The analysis is based on the results obtained by Sauer which reduce the calculations to matrix operations. These matrices consist of the triangular type, the elements of which are hyperbolic cosines or square roots, or linear combinations of both.

AUFTRIEB UND MOMENT DER EBENEN PLATTE IN SCHWACH KONVERGENTER ODER DIVERGENTER STRÖMUNG. Kurt Kraemer. ZFW, Dec., 1957, pp. 370-374. In German. Calculation, by means of conformal transformation, of the velocity distribution, normal force, and moment of a plate in a plane sink or source flow. Normal force and moments show increments proportional to the pressure gradient of the undisturbed flow; in practice they are small. Higher order terms are neglected.

OBTEKANIE TONKOGO ZATUPLENNOGO KONUSA PRI BOL'SHOI SVERKHZVUKOVOI SKOROSTI. G. G. Chernyi. AN SSSR Dokl., Aug. 1, 1957, pp. 681-683. In Russian. Derivation of an approximate solution for hypersonic flow past a thin blunt-nosed cone, and comparison of obtained results with experimental data. The case of a symmetrical flow with velocity V is considered, and the problem is reduced to the equivalent problem of plane unsteady motion of a gas with cylindrical waves. It is assumed that the mass concentration in the perturbed region is located on the generated shock wave and moves with it.

THE EFFECTS OF AFTERBODY LENGTH AND MACH NUMBER ON THE NORMAL FORCE AND CENTER OF PRESSURE OF CONICAL AND OGIVAL NOSE BODIES. W. E. Buford. J. Aero. Sci., Feb., 1958, pp. 103-108. Results of measurements of the normal force and center of pressure of bodies of revolution at supersonic Mach Numbers from 1.36 to 4.0. Conical and ogival nose bodies with cylindrical afterbody lengths varying systematically from 0 to 11 calibers are studied. The purpose of the study is to describe in a systematic manner the variation of the body aerodynamic characteristics with afterbody length and Mach Number. These data are in reasonable agreement with the theoretical values predicted by Van Dyke's improved treatment of the first-order axial and cross flows.

NON-UNIFORM SHEAR FLOW PAST CYLINDERS. J. D. Murray. Quart. J. Mech. & Appl. Math., Nov., 1957, pp. 406-424. Development of a method by which an approximation of any desired degree of accuracy to the stream functions can be obtained for two types of variable shear flows past finite cylinders. The two shear distributions in the free stream can be approximated to the linear shear distribution and the shear present in an unretarded incompressible boundary layer, respectively. In every case the stagnation streamline is displaced from the position opposite the line of symmetry of the cylinder, and general expressions are obtained for this displacement.

THE STEADY TWO-DIMENSIONAL FLOW OF VISCOUS FLUID AT LOW REYNOLDS NUMBERS PASSING THROUGH AN INFINITE ROW OF EQUAL PARALLEL CIRCULAR CYLINDERS. K. Tamada and H. Fujikawa. Quart. J. Mech. & Appl. Math., Nov., 1957, pp. 425-432. Analysis based on Oseen's equations of motion showing that the drag acting on any one of the cylinders in the row is always greater than that acting on the same cylinder when it is immersed alone in an unlimited uniform flow with the same velocity. In particular, when the Reynolds Number of the flow is sufficiently small, the drag is found to be proportional to the flow speed U, while it is proportional to $U/\log U$ in the case of a single cylinder.

LOW SPEED EXPERIMENTS ON THE WAKE CHARACTERISTICS OF FLAT PLATES NORMAL TO AN AIRSTREAM. R. Fail, J. A. Lawford, and R. C. W. Eyre. Gt. Brit., RAE TN Aero. 2516, June, 1957. 39 pp. Test results show that the ef-

fects of aspect ratio on drag, base pressure and flow pattern are small up to A = 10. All the plates shed turbulent eddies at particular frequencies. It is further proved that large changes in the shape of low aspect ratio plates have very small effects on the aerodynamic characteristics, but that perforating the plate can eliminate the regular shedding of eddies and reduce the random low frequency velocity fluctuations.

MEASUREMENTS OF SHOCK DRAG DUE TO NOSE BLUNTNESS FOR A 40° CONE-CYLINDER AT M = 1·97. M. A. B. Narayanan. Aero. Soc. India J., Aug., 1957, pp. 44-49. Measurements using a direct reading drag balance at zero angle of attack. The obtained nose drag coefficients are plotted against the area of nose bluntness, and the body drag is estimated beyond the balance range. It is shown that the drag is roughly proportional to the nose bluntness area up to 0.02 in.^{2}

AN INVESTIGATION OF TWO-DIMENSIONAL SUPERSONIC BASE PRESSURES. A. F. Charwat and J. K. Yakura. J. Aero. Sci., Feb., 1958, pp. 122-128. 16 refs. Investigation of the base pressure behind wedges at Mach Numbers 2 and 3 in the laminar and the transitional regime. Temperature and velocity traverses through the mixing zone are shown, and exploratory investigations of the wake vortex by the use of hot wires and flow-visualization techniques are described. It is found that the laminar two-dimensional base pressure agrees well with Chapman's theoretical predictions. The shear layer exhibits gross velocity distribution characteristic of the free jet mixing zone, but also shows disturbances that originate in the expansion-turning of the oncoming boundary layer. A trailing vortex was observed and is explained in terms of nonuniform mixing rate in the wake.

ON THE NUMERICAL CALCULATION OF DETACHED BOW SHOCK WAVES IN HYPERSONIC FLOW. P. R. Garabedian and H. M. Lieberstein. J. Aero. Sci., Feb., 1958, pp. 109-118. 14 refs. Derivation of a method for calculating examples of hypersonic flow with a detached bow shock wave past a bluff axially symmetric body. The form of the shock wave is assumed, and the analysis is based on a Cauchy problem for the stream function in the subsonic region, where the motion is governed by a partial differential equation of the elliptic type. Includes reformulation of the Cauchy problem which leads to a stable scheme for computation of the flow by finite differences. Numerical examples at free-stream Mach Number 5.8 are presented in which the flow is determined throughout the subsonic region, and, in particular, the detachment distance, the location of the sonic line, and the pressure distribution along the body are calculated.

A REEXAMINATION OF THE USE OF SIMPLE CONCEPTS FOR PREDICTING THE SHAPE AND LOCATION OF DETACHED SHOCK WAVES. Appendix A - DEVELOPMENT OF GENERAL ELLIPTIC EQUATION GIVING THE VARIATION IN DETACHMENT DISTANCE BETWEEN $\delta_0 = \delta_{det}$ AND $\delta_0 = 90^\circ$ FOR CONE-CYLINDERS AND WEDGE-SLABS. Appendix B - METHOD FOR CALCULATING ELLIPTIC VARIATION OF C FOR CUT CYLINDERS AND SPHERES. Appendix C - DERIVATION OF METHOD FOR CALCULATING η FOR KNOWN SHOCK SHAPES. Appendix D - PROCEDURE FOR CALCULATING SHOCK SHAPE. Eugene S. Love. US, NACA TN 4170, Dec., 1957. 53 pp. 38 refs. Study which shows that simple concepts and modifications of existing methods can yield good predictions for many nose shapes and for a wide range of Mach Numbers.

ON A THEORY OF SHOCK WAVES IN LOCALLY SUPERSONIC ZONE AND A NEW BOUNDARY-VALUE PROBLEM FOR TRICOMI'S EQUATION. Shunichi Tsugé. Phys. Soc. Japan J., Dec., 1957, pp. 1,412-1,419. 11 refs. Analysis of the hodograph behavior for a shock wave in transonic flow with a nonuniform initial state. Besides the polar shock, two conditions are derived which, as a special case, comprise Busemann's spine and serve to eliminate the indeterminateness which constitutes a specific difficulty for the treatment of high subsonic flow with shock waves. Applying these three equations to the transonic flow over an airfoil, a new boundary-value problem is proposed. The problem still involves indeterminateness, but in the special case of an airfoil with a ridge, it can be simplified so as to develop a further analysis.

A NOTE ON MOTT-SMITH'S SOLUTION OF THE BOLTZMANN EQUATION FOR A SHOCK WAVE. Akira Sakurai. J. Fluid Mech., Dec., 1957, pp. 255-260. Investigation of the Mott-Smith interpolation formula for the shock wave problem showing it to be, with a modification, the solution of the Boltzmann equation at large Mach Number in a finite region of molecular velocity space. The modification gives a unique determination of the shock wave thickness, removing the ambiguity for this in Mott-Smith's formula.

A NOTE ON THE STAND-OFF DISTANCE OF THE SHOCK IN HIGH SPEED FLOW PAST A CIRCULAR CYLINDER. G. B. Whitham. Commun. on Pure & Appl. Math., Nov., 1957, pp. 531-535. ONR-sponsored extension of Lighthill's theory for the sphere to the case of a circular cylinder. A shape for the shock is assumed, which is taken to be a portion of a sphere in the region around the axis of symmetry. The vorticity ω just behind the shock is found to be proportional to the distance r from the plane of symmetry, and can be transcribed. From this relation the vorticity is equated in terms of the stream function to form a linear equation, capable of a straightforward solution with Bessel functions.

THE DIFFRACTION OF A RAREFACTION WAVE BY A CORNER. J. B. L. Powell. J. Fluid Mech., Dec., 1957, pp. 243-254. Investigation of the effect of a small disturbance on the

flow in a complete rarefaction wave, as in the case of flow produced by the rupture of a membrane originally separating a compressible gas from a vacuum. The perturbation arises from a rigid boundary slightly inclined to the direction of the flow. The growth of the perturbed region is studied, and the pressure field is calculated for diatomic gases. The nature of the expanding boundary of the perturbed region is investigated. Arguments are put forward which suggest that this boundary can be a weak shock in certain circumstances. A second shock may also appear in some cases, following the first and of greater strength.

A METHOD FOR SOLVING THE SECOND ORDER PROBLEMS OF AXIALLY SYMMETRIC SUPERSONIC FLOW. Takashi Tani. Japan Soc. Aero. Eng. J., Nov., 1957, pp. 306-308. In Japanese. Solution of the second-order equation of the perturbation stream function for axially symmetric irrotational compressible flow, assuming that the axial component of perturbation velocity is of the same order as the radial velocity. In some cases the equation can be solved in closed form. The generalized conical flow is represented by an elementary integral.

ON THE APPLICATION OF A STATISTICAL APPROXIMATION TO THE THEORY OF TURBULENT DIFFUSION. P. H. Roberts. J. Math. & Mech., Nov., 1957, pp. 781-799. 10 refs. Analysis from the Eulerian standpoint to evaluate the probability that one particle at a certain point in space at the zero time should, at a later time t, have been carried to a distance x from its starting point. It is shown that by using a reasonable statistical hypothesis relating the fourth statistical moments to those of lower order, a knowledge of the spectrum of the turbulent velocity field suffices, in principle, to determine this Eulerian probability uniquely. Various approximations are developed and discussed.

TURBULENCE MEASUREMENTS IN MULTIPLE INTERFERING AIR JETS. J. C. Laurence and J. M. Benninghoff. US, NACA TN 4029, Dec., 1957. 37 pp. 13 refs. Determination of turbulent and mean-flow characteristics of several noise-suppression multiple-jet nozzles from hot-wire-anemometer measurements for flow conditions of Mach Number 0.3 and Reynolds Number of 2.06×10^6 per foot. Turbulent mixing, as indicated by reduced intensity and scale of the turbulence, occurs closer to the nozzle in interfering than in noninterfering jets. The turbulence spectra show that the multiple jets redistribute energy. The more rapid mixing of the interfering jets and shifting of the spectral energy of the interfering jets may explain, in part, the suppression of noise by these nozzles.

Internal Flow

ON THE GENERATION OF THE STREAMWISE COMPONENT OF VORTICITY FOR FLOWS IN ROTATING PASSAGES. A. G. Smith. Aero. Quart., Nov., 1957, pp. 369-383. Presentation of a method which may be regarded as an extension of the methods previously applied to the calculation of secondary flows in stationary passages. Includes an approximate calculation of the streamwise vorticity generated in a simple axial-flow impeller, assuming an approximate shape of the streamline (as in the case of secondary flows) before the calculation of the secondary flows.

TURBULENT FLOW IN CHANNELS WITH POROUS WALLS. S. W. Yuan. Polytech. Inst. Bklyn., Dept. Aero. Eng. & Appl. Mech., PIBAL Rep. 407, Aug., 1957. 13 pp. Development of an exact solution of the Reynolds equations with injection or suction as a boundary condition. A perturbation method is used to solve the third-order nonlinear differential equation for small and moderate flows through the porous walls. It is assumed that the maximum axial velocity and the injection or suction velocity are varying as an exponential function of x. The axial velocity distribution is expressed as functions of the velocity through the porous walls, the axial pressure gradient, and the empirical constant K.

Stability & Control

BEITRAG ZUR STABILITÄT VON SELBSTSTEUERNDEN FLUGKÖRPERN. Hans St. Stefaniak. ZFW, Dec., 1957, pp. 347-355. 11 refs. In German. Application of methods used in the technique of stability and control to the calculation of the longitudinal stability of free-falling bodies with automatic control.

STUDIO ANALITICO DELLA VITE UTILIZZANDO ESPERIENZE ESEGUITE ALLA GALLERIA DEL VENTO ORIZZONTALE E METODO DI PROVA DI MODELLI IN ARIA LIBERA. Ermanno Bazzocchi. L'Aerotecnica, Aug., 1957, pp. 178-200. 22 refs. In Italian. Analytical study of spin on the basis of tests in a horizontal wind tunnel, including a method of testing models in free air. Fundamental equations of the steady spin are given, together with a method for measuring the aerodynamic coefficients. Also presented are experimental results obtained on a training aircraft scale model.

AUTOROTATION OF FUSELAGES. M. H. Clarkson. (IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 770.) Aero. Eng. Rev., Feb., 1957, pp. 33-36. Wind-tunnel investigation on a fighter-type aircraft model to determine the source of autorotative moment in a flat spin where the spin axis passes relatively close to the center of gravity of the aircraft. Results indicate that autorotation is due to an aerodynamic side force originating on the fuselage nose. The autorotation moment is found to be intimately connected with flow seperation and therefore sensitive to surface roughness, Reynolds Number, and the cross-sectional shape of the fuselage. It is concluded that means need to be developed for correlating spinning tunnel Reynolds Number with flight Reynolds Numbers

and/or means need to be developed for conducting model spin tests at or near flight Reynolds Numbers.

Wings & Airfoils

INSTALLATION DE LA PORTANCE SUR UN PROFIL MUNI D'UNE FENTE DE SOUFFLAGE AU BORD DE FUITE ET CORRECTION DUE A L'ENVERGURE FINIE. R. Hirsch. France, Min. de l'Air NT 69, 1957. 75 pp. SDIT, 2 Av. Porte-d'Issy, Paris 15, Frs. 1,000. In French. Investigation of lift on a profile having an aspiration slot on the trailing edge and correction due to the finite span. The circulation about the profile, and hence its lift, is directly related to a condition of a point in the rear, similar to the Joukowski condition for classical stationary and nonstationary problems. The vortex wake arising at the trailing edge is described by an equation, corresponding to that of Wagner, which gives the radius of curvature of the wake at the point. The discussion includes the importance of the law governing the recession of the vortex elements and its connection with the dissipation of these elements by viscosity. Includes derivation of laws governing the retardation of the jet and extension to a wing of finite span. Expressions for lift and drag are compared with experimental values for the stationary problem when spanwise circulation distribution is elliptical. The case of wing-fuselage interaction is also considered.

DVIZHENIE KRYLA KONECHNOGO RAZMACHA SO SVERKHZVUKOVOI SKOROST'IU. S. Kadyrov. AN SSSR Otd. Tekh. Nauk Izv., Aug., 1957, pp. 35-40. In Russian. Study of the motion of a wing with finite span at supersonic speed. The solution of the problem is reduced to the solution of four cases: (a) gas flow in a space restricted by the surface of the wing and the shock wave; (b) gas flow in a space restricted by the surface of the wing and the characteristic surface; (c) gas flow in a space between two characteristic surfaces; and (d) gas flow between the characteristic surface and the shock wave.

THE MOVING AEROFOIL IN SHEAR FLOW IN THE NEIGHBOURHOOD OF A PLANE BOUNDARY. D. E. Edmunds. Quart. J. Mech. & Appl. Math., Nov., 1957, pp. 448-464. Extension of Green's method developed for potential flow, assuming an inviscid, incompressible fluid acting on a two-dimensional airfoil. Expressions are obtained in series form for the forces and couples acting on a fairly general type of airfoil; the flat plate airfoil is given a more detailed consideration.

ZUR ANWENDUNG DER ÄHNLICHKEITSREGELN DER KOMPRESSIBLEN STRÖMUNG IN DER RÄUMLICHEN TRAGFLÜGELTHEORIE. Erich Truckenbrodt. ZFW, Dec., 1957, pp. 341-346. In German. Application of the compressible-flow similarity rules (the Prandtl-Glauert-Ackeret rule and the von Kármán rule) to problems of the three-dimensional wing theory for subsonic, supersonic, and sonic flows.

EXPERIMENTELLE UNTERSUCHUNG ÜBER DIE AUFSPULLÄNGE DER INSTABILEN UNSTETIGKEITSFLÄCHE HINTER EINEM TRAGFLÜGEL VON ENDLICHER SPANNWEITE. Elmar Rohne. ZFW, Dec., 1957, pp. 365-370. 16 refs. In German. Experimental investigation of the length over which the trailing vortex sheet is rolled up into two vortex cores and the distance between the rolled-up vortices for a rectangular and a trapezoidal wing with GP 387 airfoil sections, each with the wing tips sharp and rounded off.

DAS GESCHWINDIGKEITSFELD HINTER EINER AUFTRIEB ERZEUGENDEN TRAGFLÄCHE VON ENDLICHER SPANNWEITE. Rudolf Wurzbach. ZFW, Dec., 1957, pp. 360-365. 12 refs. In German. Analysis of the velocity field of a lifting airfoil of finite span. A method is given for the determination of the induced velocity field, taking into account the rolling-up and displacement of the vortex street. The theory is in good agreement with Muttray's measurements.

CURVES SUITABLE FOR FAMILIES OF AEROFOILS WITH VARIABLE MAXIMUM THICKNESS POSITION, NOSE RADIUS, CAMBER AND NOSE DROOP. L. H. Tanner. Gt. Brit., ARC CP 358, 1957. 26 pp. BIS, New York, $0.72. Presentation of examples showing that it is possible to design geometric curves, given by single explicit equations, and having shapes suitable for use as airfoil sections. A family of sharp-nosed sections with variable maximum thickness position is described, and a method of rounding the leading edge of any sharp-nosed section is suggested. A family of curves with camber and nose droop is presented, and it is shown, that the methods used can be adapted to produce other section variations if required.

THE DOWNWASH OF SWEPT-BACK WINGS HAVING THE LEADING EDGE SEPARATION. Akira Mitsuyasu. Japan Soc. Aero. Eng. J., Nov., 1957, pp. 301-305. In Japanese. Experimental and theoretical investigation which concludes that the occurrence of part-span vortices increases the downwash at the tailplane. The downwash cannot be calculated from lift distribution alone, but must also include consideration of the leading edge separation vortices.

ESTABLISHMENT OF LIFT ON AN AEROFOIL WITH A JET FLAP. R. Hirsch. Aircraft Eng., Dec., 1957, pp. 366-375. Analysis for the circulation lift around an airfoil section which has a trailing edge jet. The circulation is directly dependent on a trailing edge condition similar to the Joukowski condition. The problem is governed by an equation similar to the Wagner equation, into which is introduced the curvature of the downwash at the trailing edge. The movement of elementary vortices in the downwash is directly dependent on the viscous damping of the vorticity. This effect has been considered, and the drag law of the jet behind the nozzle established. The velocity distribution can be found at

any instant, and from this all aerodynamic forces can be calculated. The method is applied to two cases and comparison made with experimental results.

EXPERIMENTAL INVESTIGATION OF LIFT, DRAG, AND PITCHING MOMENT OF FIVE ANNULAR AIRFOILS. H. S. Fletcher. US, NACA TN 4117, Oct., 1957. 25 pp. 11 refs. Test results on annular airfoils with equal projected areas, but with varying chords and diameters, covering aspect ratios of 1/3, 2/3, 1.0, 1.5, and 3.0. The results show that the effects of aspect ratio on the aerodynamic-center location are similar for annular and unswept airfoils. The annular airfoils have a larger maximum lift-drag ratios below an aspect ratio of 2.4 than plane rectangular airfoils with faired tips. The lift-curve slope is twice the lift-curve slope for a plane unswept airfoil of the same aspect ratio, and the induced drag coefficient is one-half the induced drag coefficient of an elliptic airfoil. The wake flow characteristics of the annular airfoils are similar to the characteristics of low-aspect-ratio or highly swept airfoils.

SUPERSONIC AIRFOIL PERFORMANCE WITH SMALL HEAT ADDITION. Artur Mager. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 768. 19 pp. Members, $0.50; nonmembers, $0.85. Presentation of an analytical method for rapid evaluation of aerodynamic effects arising from the addition of small amounts of heat near supersonic, two-dimensional airfoils. It can also be applied to shockless, inviscid flows without heat conduction, neglecting the mechanism of desired heat-addition in both cases. It is shown that even small amounts of heat generate substantial pressure rise and thus cause appreciable changes in aerodynamic coefficients.

ON OPTIMUM THIN LIFTING SURFACES AT SUPERSONIC SPEEDS. H. Yoshihara, J. Kainer, and T. Strand. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 782. 15 pp. 22 refs. Members, $0.50; nonmembers, $0.85. Investigation of the problem of optimizing wings for drag due to lift, based on the linearized supersonic theory. Minimum drag is obtained for prescribed values of lift and pitching moment, and the required wing twist and camber are presented as a summation of ten quasi-conical expressions, the coefficients of this series being determined by the calculus of variations. The harmonic method of Nikolsky, Kogan, Germain, and Graham is used to check the adequacy of the ten-term series. Analyzed wings include delta and swept-back wings with subsonic and supersonic edges.

THE FORMATION OF REGIONS OF SEPARATED FLOW ON WING SURFACES. II - LAMINAR SEPARATION BUBBLES AND THE MECHANISM OF THE LEADING-EDGE STALL. L. F. Crabtree. Gt. Brit., RAE Rep. Aero.2578, July, 1957. 22 pp. 20 refs. Discussion and explanation of the characteristics of the bubbles on thin and moderately thin aerofoil sections at low speeds. Owen's criterion for distinguishing between long and short bubbles is further proven. Despite the fact that Owen's criterion distinguishes between the static states of the two bubble kinds, the test results also show that there is no universal value of the boundary layer Reynolds Number at separation.

SOME SIMPLE CONICAL CAMBER SHAPES TO PRODUCE LOW LIFT-DEPENDENT DRAG ON A SLENDER DELTA WING. G. G. Brebner. Gt. Brit., RAE TN Aero. 2529, Sept., 1957. 27 pp. Presentation of some theoretical aerodynamic wing characteristics for wings having two types of simple conical camber to produce zero load on the leading edge at the design lift coefficient. Calculations are made using slender wing theory. It is shown that the drag due to lift is comparable with the low values found by Smith and Mangler for wings with more "wavy" camber lines.

AEROELASTICITY

A SEMI-EMPIRICAL ANALYTICAL METHOD OF OBTAINING AERODYNAMIC DERIVATIVES. N. H. Van Dorn. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 783. 11 pp. Members, $0.35; nonmembers, $0.75. Development of a method, capable of being programmed on a computer, to determine aerodynamic data for stability and load analysis, and to determine the means of distributing the loads. The coefficient calculations are combined with an aeroelastic method, using the modified Weissinger method for its aerodynamic basis. In the first step rigid data increments are fed into the load and coefficient program along with the airplane geometry inertia breakdown and stiffness data. The machine then calculates elasticized derivatives. The output of this program is then fed into a five degree of freedom (roll, pitch, yaw, etc.) free body motion program along with specific control surface motion imputs. These in turn are then fed into the loads and coefficient program along with the rigid data increments. The machine then calculates detailed balanced airplane loads, including inertia reactions.

A LINEAR PERTURBATION METHOD FOR STABILITY AND FLUTTER CALCULATIONS ON HYPERSONIC BODIES. Maurice Holt. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 793. 11 pp. Members, $0.35; nonmembers, $0.75. Derivation of equations governing linear perturbations in terms of three space variables and time for steady supersonic potential flow past bodies of revolution. A general method of solution is described, and the theory is simplified by assuming a potential flow. This technique can be used in most flutter calculations and for estimating the contribution to stability derivatives from the rear part of the body, and can be applied in principle to the case of nonisentropic flow fields as well. Two applications are described: calculation of the stability derivatives associated with the ex-

terior surface of a converging conical duct to represent the contribution of a typical hypersonic afterbody, and the determination of the aerodynamic forces arising in the panel flutter of a finite circular cylinder.

EFFECT OF QUASI-STEADY AIR FORCES ON INCOMPRESSIBLE BENDING-TORSION FLUTTER. J. Dugundji. J. Aero. Sci., Feb., 1958, pp. 119-121. Development of explicit solutions for the bending-torsion flutter of a two-dimensional airfoil in incompressible flow under the assumptions that the Theodorsen function is set equal to a real constant and the diagonal virtual mass terms are negligible. For the case of small bending to torsion frequency ratio, a comparison is made of quasi-steady solutions with an earlier empirical expression suggested by Theodorsen and Garrick for the nonsteady case. The importance of the c.g. location for these small cases is re-emphasized, and the possibility of flutter at zero air speed is indicated.

AN EXPERIMENTAL AND THEORETICAL STUDY OF THE EFFECT OF FUEL ON PITCHING-TRANSLATION FLUTTER. Appendix - FLUTTER AND DIVERGENCE EQUATIONS FOR TWO-DIMENSIONAL WING-TANK CONFIGURATION. John L. Sewall. US, NACA TN 4166, Dec., 1957. 42 pp. 14 refs. Analytical flutter studies for two-dimensional fuel-loaded wing models, and comparison of experimental results for bending-to-torsion frequency ratios near one. One of the models is made so that water, simulating fuel, can be carried internally in three compartments separated by sealed spanwise partitions. Flutter speeds of this model for all fuel loads are highest for the compartmental-emptying sequence from front to rear. In the other model, fluid is carried externally in a pylon-mounted fuel tank without baffles. Theory and experiment are in good agreement for both models.

VIBRATIONS OF TWISTED BEAMS II. William Boyce and George Handelman. Rensselaer Polytech. Inst. Dept. Math., RPI MathRep. 11 (AFOSR TN 57-773) [AD 148003], Dec. 19, 1957. 24 pp. Study of some implications of the basic equations governing the transverse vibrations of a straight, twisted beam rotating about an axis passing through one end and perpendicular to the undeflected central axis of the bar. Calculations are made, and qualitative results are presented.

ON THE CHANGE OF NATURAL FREQUENCIES INDUCED BY SMALL CONSTRAINTS. R. J. Duffin and A. Schild. J. Math. & Mech., Nov., 1957, pp. 731-758. Derivation of equations showing that when a constraint is added to a vibrating linear mechanical system, the frequency of each normal mode tends to increase. Applications are made to a membrane and the clamped plate problem.

EIGENSCHWINGUNGEN VON DÜNNWÄNDIGEN SCHALEN. A. Lisowski. Acad. Pol. Sci. Bul., No. 4, 1957, pp. 213-220. In German. Study of the natural vibrations of thin-walled shells assuming a relationship between buckling and vibration mode. It is further assumed that the fundamental vibration mode corresponds to the buckling mode. Includes determination of fundamental and harmonic oscillations.

A COMPARISON OF THEORETCAL AND EXPERIMENTAL LOADS ON THE B-47 RESULTING FROM DISCRETE VERTICAL GUSTS. Ch. E. Jackson and J. E. Wherry. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 784. 27 pp. 11 refs. Members, $0.65; nonmembers, $1.00. Study for determining whether or not realistic gust loads can be predicted using presently available techniques of dynamic analysis. Equations of motion and finite difference equations are derived, and it is concluded that the steady state theory is inadequate for an accurate prediction. It is further shown that the peak loads can be predicted using the dynamic analysis, and that the nacelle strut side bending mode and the wing fore and aft bending mode have a negligible effect on the wing vertical loads due to discrete gust encounters.

FUELS & LUBRICANTS

UNTERSUCHUNGEN ÜBER KÜNSTLICHE UND NATÜRLICHE ALTERUNG UNLEGIERTER MINERALSCHMIERÖLE. G. Spengler and H. O. Hössl. DVL Bericht No. 26, July, 1957. 70 pp. 16 refs. Westdeutscher Verlag, Köln & Opladen. In German. Investigation of artificial and natural aging of unblended mineral lubricating oils. Application of the so-called n-d-M method (refractive index-density Molecular-weight) to study the structural changes. Includes description of the Indiana, Sligh, and MAN tests.

DETERMINATION OF BURNING VELOCITY OF PENTABORANE-OXYGEN-NITROGEN MIXTURES. W. G. Berl, E. L. Gayhart, E. Maier, H. L. Olsen, and W. T. Renich. Comb. & Flame, Dec., 1957, pp. 420-430. 21 refs. Navy-supported investigation to obtain the burning velocities. Freely propagating laminar flame kernels produced by spark ignition are photographed by the flash schlieren technique, and the burning velocity is derived from the measured rate of growth of these kernels. The pentaborane-air burning velocity reaches a maximum value at a slightly greater value than the stoichiometric value. The influence of oxygen concentration on burning velocity is reported, and pentaborane flames show pronounced cellular structure of the flame front at all mixture ratios.

MATHEMATICS

THE NUMERICAL SOLUTION OF SINGULAR INTEGRAL EQUATIONS. R. C. MacCamy. Carnegie Inst. Tech. TR 19 (AFOSR TN 57-515) [AD 136500], Sept., 1957. 22 pp. Study of the singular nature of solutions at the ends of an interval of integration, concealed by polynomial approximations.

The integral equations are translated into functional relations for multi-valued analytic functions of a complex variable. From these relations information about the structure of the analytic function can be obtained and in turn translated into facts concerning the solutions of the integral equations.

APPROXIMATE SOLUTIONS OF PARABOLIC AND HYPERBOLIC PARTIAL DIFFERENTIAL EQUATIONS. Milton Lees. U. Calif. Dept. Math., TR 7, Oct., 1957. 83 pp. 18 refs. Investigation of approximate solutions for certain mixed initial-boundary value problems with emphasis on two implicit methods of approximation. The first method replaces the first boundary value problem for the partial differential equation by an initial value problem for a nonlinear system of ordinary differential equations, while the second leads to boundary value problems for nonlinear partial difference equations over a rectangular lattice. In both cases the principal aim is to establish for the approximate solutions properties which are analogous to certain well known properties of the exact solutions and, in particular, to derive random estimates in terms of a suitable norm.

NEW BOUNDS FOR SOLUTIONS OF SECOND ORDER ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS. L. E. Payne and H. F. Weinberger. U. Md. Inst. Fluid Dynamics & Appl. Math. TN BN-108 (AFOSR TN 57-651) [AD 136636], Sept., 1957. 41 pp. 11 refs. Extension of previous work on the solutions of Dirichlet and exterior Neumann problems associated with Laplace's equation, using a generalization of Rellich's identity. The results are extended to a class of non-self-adjoint second order equations, as well as to a rather large class of elliptic systems of second order differential equations.

MECHANICS

ON THE STABILITY OF ACCELERATED MOTION: SOME THOUGHTS ON LINEAR DIFFERENTIAL EQUATIONS WITH VARIABLE COEFFICIENTS. A. R. Collar. Aero. Quart., Nov., 1957, pp. 309-330. Consideration of the stability problem, and presentation of an example to show that a system stable at any constant speed can become unstable during deceleration. Some methods for the discussion of those problems are suggested, and a solution of the single second-order equation is presented. Inverse methods for sets and single equations are included, and it is shown that acceleration depends on a dimensionless "acceleration number."

MILITARY AVIATION & ARMAMENT

A RATIONAL DETERMINATION OF LOADS AND EXIT VELOCITIES OF CARTRIDGE EJECTED STORES. H. Wolf and S. Pines. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 786. 7 pp. Members, $0.35; nonmembers, $0.75. Development of a procedure to determine peak gun forces, ejection time histories, separation velocities, and dynamic structural amplification factors of cartridge ejection mechanisms for store release. Thermodynamic equations for the chemical energy exchange are derived. Since the pressure-time history of the burning powder is a sensitive function of the chamber volume, the motion of both the ejected store and the breech reaction are required. The equations of motion of the elastic restraining structure and the ejected store are derived using standard procedures. The resulting solutions are presented in the form of curves which may be used in ejection gun design.

MISSILES

LE RAYON D'ACTION D'UN ENGIN TELEGUIDE, SA DEPENDANCE A L'EGARD DE CERTAINS PARAMETRES ARBITRAIRES. H.-R. Voellmy. (Congrès Internatl. Fusées & Engins-Guidés, Paris, Dec. 3 - 8, 1956.) Fusées, July, 1957, pp. 213-218. In French. Study of the operating range of a guided missile limited to the case of a single-stage, beam-riding type. Includes analysis of design parameters and of the behaviour in vertical flight and pursuit.

TRAJECTORY PROGRAMMING FOR MAXIMUM RANGE. George Leitmann. Franklin Inst. J., Dec., 1957, pp. 443-452. Derivation of necessary conditions for the existence of an optimum direction of thrust and angle of attack for a rocket travelling in the atmosphere subject to forces of gravity, aerodynamic drag and lift. A mechanism is assumed capable of bringing about instantaneously the optimum angle of attack, that is, of providing the angle of attack-time function which yields maximum range between two specified altitudes. A method of solution is outlined and a singularity arising in the case of launch from zero velocity is discussed.

OPTIMUM BURNING PROGRAM AS RELATED TO AERODYNAMIC HEATING FOR A MISSILE TRAVERSING THE EARTH'S ATMOSPHERE. Angelo Miele. (IAF 8th Confress, Barcelona, Oct. 7 - 12, 1957.) Jet Propulsion, Dec., 1957, pp. 1, 231-1, 240. Determination of the thrust-time relationship minimizing the difference ΔG between the final and initial values of an arbitrarily specified function G(t, m, h, V, T) of time, mass, altitude, velocity, and skin temperature when the induced drag is negligible with respect to the zero-lift drag. It is shown that the totality of extremal arcs is composed of zero-thrust sub-arcs, sub-arcs to be flown with maximum engine output, and variable-thrust sub-arcs. An explicit solution is obtained for problems not involving time. Closed form solutions are derived assuming an isothermal atmosphere, negligible drag and irradiation, and a constant Stanton Number.

GENERALIZED VARIATIONAL APPROACH TO THE OPTIMUM THRUST PROGRAMMING FOR

THE VERTICAL FLIGHT OF A ROCKET. II - APPLICATION OF GREEN'S THEOREM TO THE DEVELOPMENT OF SUFFICIENCY PROOFS FOR PARTICULAR CLASSES OF SOLUTIONS. Angelo Miele and C. R. Cavoti. Purdue U., Sch. Aero. Eng. Rep. A-57-2 (AFOSR TN 57-652) [AD136638], Aug., 1957. 35 pp. Vertical flight analysis in connection with the determination of the burning program, extremizing an arbitrary function of the final values of time, mass, altitude, and velocity. It is shown that the Legendre-Clebsch condition does not provide any information at points of the constant sub-arcs and variable-thrust sub-arcs forming one extremal arc. The investigation covers flight in a uniform atmosphere and in a vacuum, and analytical proofs are presented for the latter for both single-stage and multi-stage rockets.

NAVIGATION

LES PROBLEMES DE LA NAVIGATION PAR INERTIE. M. P. Schnerb. France, ONERA, J.I.S.A., Paris, May 27-29, 1957, Comptes Rendus, Pt. 2, pp. 115-151. In French. Study of inertial navigation systems including gyroscopic reference, accelerometers, and a calculator, using two methods. The first relates acceleration to arbitrary axes, the second implies the horizontal field components, and eliminates gravity. The vertical problem is examined using the pendulum method and a free gyroscope. Includes application of Schuler's principle, and error analysis.

PHYSICS

ON FREE MOTION IN THE GRAVITATIONAL FIELD OF THE EARTH. G. C. Scorgie. Quart. J. Mech. & Appl. Math., Nov., 1957, pp. 494-499. Derivation of an approximate solution for the motion of a particle in the earth's gravitational field as modified by ellipticity of the figure of the earth; in particular, the resulting torsion of the path is calculated. The ellipticity is represented by the departure of the external field of gravity with a force varying inversely as the square of the distance from a fixed center.

THE STRUCTURE OF A SHOCK WAVE IN A FULLY IONIZED GAS. J. D. Jukes. J. Fluid Mech., Dec., 1957, pp. 275-285. Calculation of the structure for a plane shock wave moving through a completely ionized plasma of protons and electrons. It is assumed that the two species of particles behave as two seperate gases, each in a quasi-equilibrium state corresponding generally to two different temperatures. Navier-Stokes type equations with coefficients of viscosity and thermal conductivity appropriate to the two species are solved by numerical iteration.

SOME SHOCK TUBE EXPERIMENTS ON THE CHEMICAL KINETICS OF AIR AT HIGH TEMPERATURES. Saul Feldman. J. Fluid Mech., Dec., 1957, pp. 225-242. Analysis to determine the rates at which atoms and molecules react in the air that flows over a body flying through the atmosphere at hypersonic speeds. Using air as a working fluid, a series of shock tube experiments are carried out. Mach angle measurements are made to determine the state of the gas in three situations of interest. The results indicate that the dissociation and recombination relaxation times of the chemical species found in air are very fast, when compared to the time it takes a particle of gas to flow either around a blunt body in hypersonic flight or past small models in shock tubes. Thus the shock tube is shown to be an instrument capable of supplying air at high temperatures in thermodynamic equilibrium.

ONE DIMENSIONAL FLOW OF AN IONIZED GAS THROUGH A MAGNETIC FIELD. R. M. Patrick and T. R. Brogan. Avco, Res. & Advanced Devel. Div., Res. Rep. 13, Oct., 1957. 51 pp. Theoretical and experimental investigation using a shock tube to provide the ionized gas, and detailed calculation of the interaction effects. The motion of the electrons, ions, and neutral particles, composing the gas are considered, and it is found that the electrical conductivity is a tensor dependent on both the magnitude and geometry of the magnetic field. If the gas state is adjusted to produce a scalar conductivity, a flow is obtained which is completely analogous to pipe flow with friction and no heat transfer. In the case of electrical conductivity, ion slip and Hall currents are observed.

INCOMPRESSIBLE TWO-DIMENSIONAL STAGNATION-POINT FLOW OF AN ELECTRICALLY CONDUCTING VISCOUS FLUID IN THE PRESENCE OF A MAGNETIC FIELD. J. L. Neuringer and William McIlroy. IAS 26th Annual Meeting, New York, Jan. 27 - 30, 1958, Preprint 764. 11 pp. Members, $0.35; nonmembers, $0.75. Consideration of the possibility of obtaining some beneficial effects from the ionized gas cap surrounding a blunt body moving at high hypersonic speeds through the atmosphere, by impressing a magnetic field out of the body nose into the conducting gas. Test results of hydromagnetic interaction, using an appropriate flow and a flat infinite plate, show that a considerable reduction in skin friction may be possible with reasonable values of the applied magnetic intensity and electrical conductivity of the fluid.

TWO-DIMENSIONAL PROBLEMS OF THE DECAY OF MAGNETIC FIELDS IN MAGNETOHYDRODYNAMICS. T. G. Cowling and A. Hare. Quart. J. Mech. & Appl. Math., Nov., 1957, pp. 385-405. Study of the normal modes of decay of a magnetic field in the presence of steady motions in a fluid conductor. Slow motions are considered by perturbation methods, which show that to a first approximation the motion always increases the rate of decay in the lowest mode. For fast motion, there exists a limited class of modes little affected by the motion, in which the lines of force and streamlines nearly coincide. The two special cases studied are those of streaming in a

fluid slab between parallel walls and of nonuniform rotation in a circular cylinder. The motion is found to transport and distort the field and to increase the rate of decay in the lower modes, roughly proportional to the 2/3 power of the velocity.

EMISSIVITY ESTIMATES FOR HEATED NO. A. Thomson. CIT Jet Propulsion Lab. TR 6, Nov., 1957. 44 pp. USAF-supported emissivity calculations between 4,000°K. and 8,000°K. for a range of optical densities, assuming statistically distributed band positions and intensities. Results differ by 50% from those described by Kivel, Mayer, and Bethe.

THE PARTITION OF ENERGY IN HYDROMAGNETIC TURBULENCE. S. Chandrasekhar. Ann. Phys., Dec., 1957, pp. 615-626. Study of the partition of energy between the velocity and magnetic fields. The discussion is restricted to the inertial range of eddy sizes which does not include the largest energy containing eddies. On a particular theory for stationary, homogeneous, and isotropic turbulence it is shown that in this inertial sub-range the spectra of the magnetic and kinetic energies are both Kolmogorovian with a constant ratio of amplitudes; further, that in this range, the energy in the magnetic field is 1.6265 times the energy in the velocity field.

A MATHEMATICAL FOUNDATION FOR RADIATIVE TRANSFER THEORY. R. W. Preisendorfer. J. Math. & Mech., Nov., 1957, pp. 685-730. 20 refs. Presentation of a set of physically motivated axioms phrased in the language of measure theory from which, as a special case, the salient features of radiative transfer theory may be rigorously deduced. The manifold problems of the theory are then examined in terms of measure theory and functional analysis. An explanation is made of the notions of optical medium, radiant energy, the evolution of radiant energy in an optical medium, and the transfer of radiant energy in an optical medium.

THE EFFECT OF A MAGNETIC FIELD ON STOKES FLOW IN A CONDUCTING FLUID. J. Fluid Mech., Dec., 1957, pp. 304-308. Analysis of low Reynolds Number flow of a conducting fluid past a sphere. The classical Stokes solution is modified by a magnetic field which, at infinity, is uniform and in the direction of flow of the fluid. Experiments on the motions of small spheres in a column of mercury are made, the magnetic field being produced by a surrounding coil carrying a current.

POWER PLANTS

Jet & Turbine

NIEKTÓRE ZAGADNIENIA AERODYNAMIKI DRGAJĄCYCH ŁOPATEK SPRĘŻAREK. Jerzy Kacprzyński. Arch. Budowy Maszyn, No. 3, 1957, pp. 307-345. 25 refs. In Polish, with summaries in English and Russian. Review of the aerodynamic problems concerning the vibration of axial-flow compressor blades. The blade vibrations are divided into three groups according to their origin: vibrations of "mechanical" type, e.g., vibrations due to missbalancing, vibrations due to aerodynamic forces (varying periodically), and self-excited vibrations, the two latter types being both of aerodynamic origin. The damping of blade vibrations is also considered.

Ram-Jet & Pulse-Jet

PILOT COMBUSTION CANS EMPLOYING A LARGE SCALE RECIRCULATION FLOW PATTERN. H. G. Lyall. Gt. Brit., NGTE Memo. M.305, Sept., 1957. 33 pp. Description of a pilot combustion can suitable for use as the first stage of a ramjet primary zone, in which the flame is stabilized by a large scale recirculation flow pattern. The recirculation is established behind the shrouded cone which forms the front of the can, and and is carefully fed from several injection stations. This system is a distinct improvement on the "single row can," in that despite a reduced stability range the combustion efficiency, and thus the heat release, is higher. When compared with the "pepperpot" system in which the combustion zone is fed by many small jets, with no major flow reversal, the performance of the shrouded cone system is shown to be slightly inferior with premixed vaporized combustibles but less sensitive to the presence of liquid fuel at low inlet air temperature.

Rocket

ESSAI D'ETUDE THEORIQUE DES VERNIS DECOMPOSABLES POUR PROTECTION DES PAROIS DES CHAMBRES DE COMBUSTION. H. Gelly. (Congrès Internatl. Fusées & Engins-Guidés, Paris, Dec. 3 - 8, 1956.) Fusées, July, 1957, pp. 219-228. 13 refs. In French. Theoretical study of decomposable varnishes for protecting the walls of combustion chambres. The outline of the basic principles shows the need for covering the heated surface of the combustion chamber with a substance which decomposes endothermically and thus prevents the substrata from reaching the maximum combustion temperature. The thickness of protection would depend upon the required duration of heating and thus the system is indicated for short period use, e.g., rockets. Includes discussion of some experimental materials and presentation of data for the coefficients of thermal conductivity. An analysis is made of the thickness and properties required of a varnish under given combustion conditions.

AN OPTIMUM DESIGN FOR A SEMI-INFINITE ROCKET WALL CONTAINING A CIRCUMFERENTIAL KEYWAY. B. W. Shaffer, Ira Cochin, and Morton Mantus. IAS 26th Annual Meeting, New York, Jan. 27 - 30, 1958, Preprint 767. 15 pp. Members, $0.50; nonmembers, $0.85. Presenta-

tion of the relationships between a system of axially symmetric loads applied to a thin circular cylinder and the resulting deformations, in a form adaptable to numerical calculations. These relationships are applied to the problem of the rocket-wall. As a result a simple design formula is derived specifying the length of cylinder from the keyway to the rocket end needed to obtain maximum stiffness in the structure while making most economical use of the material.

PROPELLERS

DEVELOPMENT OF A PROPELLER BLADE TORSIONAL DEFLECTION ANALYSIS FOR SOLUTION ON A HIGH SPEED DIGITAL COMPUTER. J. P. Cooper. USAF WADC TR 57-528 [AD130998], Sept., 1957. 39 pp. Method derived for thin, solid, pretwisted propeller blade segments and then applied to a combined propeller strip and blade torsional deflection analysis. "Generalized" aerodynamic pitching moment coefficient data are developed for use in this combination with an iterative solution to determine accurately the aerodynamic moment, blade torsional deflection, and propeller performance with the resulting "live" twist. Accuracy survey results are also presented, and those obtained with the developed method are compared with results measured by the NACA.

ROTATING WING AIRCRAFT

AN ANALYTICAL PROCEDURE FOR THE PRELIMINARY STRUCTURAL AND DYNAMIC DESIGN, AND WEIGHT ESTIMATION OF HELICOPTER ROTOR BLADES. Abner Rasumoff. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 811. 15 pp. Members, $0.50; nonmembers, $0.85. Discussion of a method for simultaneously designing and analyzing a rotor blade, using specified structural and dynamic design criteria. This procedure is suited for optimization or parametric studies comparing different types of propulsion systems and different gross weight helicopters, and also for determining the optimum rotor parameters of a particular helicopter.

DIRECT ANALOG METHOD OF ANALYSIS OF THE VERTICAL FLIGHT DYNAMIC CHARACTERISTICS OF THE LIFTING ROTOR WITH FLOATING HUB. R. H. MacNeal. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 806. 23 pp. 12 refs. Members, $0.65; nonmembers, $1.00. Application of the method to rotating wing aircraft analysis. The basic component in the electrical model of a rotor blade is the analogy for the vibration of beams. To this are added electrical circuits that simulate the effects of centrifugal inertia forces, Coriolis forces, aerodynamic forces, control mechanism, etc. The completed electrical model permits the direct simulation of such conditions as flutter, transient response to controlled changes in cyclic pitch, and dynamic response to harmonic load variations.

CONTROL RESPONSE MEASUREMENTS ON A SINGLE-ROTOR HELICOPTER (WESTLAND "DRAGONFLY"). A. R. S. Bramwell. Gt. Brit., RAE TN Nav. 19, July, 1957. 31 pp. Presentation of flight tests to determine the longitudinal response to sudden movements of the cyclic and collective pitch controls. The measured response to cyclic pitch control agrees well with theoretical calculations. It is also shown that the response fails to satisfy NACA maneuverability criterion, except perhaps at low speed. It is found possible to obtain the rotor derivative z_w from the response to cyclic and collective pitch displacements. Measurements of speed, attitude, and acceleration are made in control-incited phugoid oscillations, and a method is given for using them in conjunction with trim measurements in order to obtain all the longitudinal stability derivatives.

STRUCTURES

Bars & Rods

AN INVESTIGATION OF THE SOLUTION OF THE TORSION PROBLEM FOR A PIERCED TRIANGULAR SHAFT BY RELAXATION METHODS. B. V. Saroja. Aero. Soc. India J., Aug., 1957, pp. 35-43. Presentation of a critical examination of the problem. Certain discrepancies associated with the vanishing of the total residual over a hole (which were noted in the earlier solutions) are explained, and a detailed solution over three successive nets is given.

Beams & Columns

STATICS AND DYNAMICS OF NON-UNIFORM CURVED BEAMS AND PRISMATIC SHELLS. F. F. Ehrich and J. P. de Vries. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 771. 15 pp. Members, $0.50; nonmembers, $0.85. Presentation of an analysis useful for numerical calculations associated with curved beams and prismatic shells of arbitrary plan form and non-uniform thickness, including both static and dynamic problems for the two-dimensional case. The analysis is of the initial value type, analogous to the Holzer method for torsion, the Myklestad method for beams, and Ehrich's analysis for discs; and is formulated in terms of a single loading point or a single elastic element of the beam or shell. All common boundary condition types are presented in tables, and the effects of elastic supports and of the stiffening or buckling in tension or compression are investigated, as well as rotary inertia effects.

SOME EFFECTS OF CURVATURE ON FRAMES. R. W. Westrup and Philip Silver. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 778. 15 pp. Members, $0.50; nonmembers, $0.85. Review of an exact theoretical solution for the stress distribution of simple plate elements, and development of an approximate solution applicable

to more general cross-section shapes. Good agreement between the two theories is indicated for the basic model where they can be compared. An "effective area" concept is defined, and design charts of its variation with the curvature parameter are presented. Results of the experimental investigation of stress distribution and ultimate crippling stress of a typical frame specimen are in excellent agreement with the approximate theoretical solution.

ANALYSIS OF ELLIPTICAL RINGS FOR MONOCOQUE FUSELAGES. Stanley Kaufman. J. Aero. Sci., Feb., 1958, pp. 98-102. Extension of the solution obtained by Wise for the external and internal forces of a prismatic ring subjected independently or collectively to any combination of three generalized loading conditions parallel to the plane of the ring - a radial force, a tangential force, and an applied moment anywhere on the ring. A more general shape is considered - the prismatic elliptical ring subjected to the following three loading conditions parallel to the plane of the ring: (a) a force parallel to the major axis; (b) a force parallel to the minor axis; and (c) an applied moment anywhere on the ring.

Connections

CREEP AND STATIC STRENGTHS OF LARGE BOLTED JOINTS OF FORGED ALUMINUM ALLOYS UNDER VARIOUS TEMPERATURE CONDITIONS. L. Mordfin, G. E. Greene, N. Halsey, R. H. Harwell, Jr., and R. L. Bloss. IAS 26th Annual Meeting, New York, Jan. 27 - 30, 1958, Preprint 779. 23 pp. Members, $0.65; nonmembers, $1.00. Experimental investigation under heating and cooling conditions accomplished by immersion in oil baths in a temperature range from room temperatures to 400°F. Some test results are compared with calculated values, and a satisfactory agreement is obtained. It is shown that oil environment as well as the size of the joints has no significant effect on the creep properties of joints.

CREEP DEFORMATION PATTERNS OF JOINTS UNDER BEARING AND TENSILE LOADS. E. G. Bodine, R. L. Carlson, and G. K. Manning. US, NACA TN 4138, Dec., 1957. 36 pp. Experimental investigation of the bearing and tensile loads interaction. A specimen is designed for this purpose possessing some of the general features of pin and rivet joint connections, and an apparatus is constructed to apply both bearing and tensile loads to the model. Deformation measurements are made by use of a photogrid printed on the joint model.

Cylinders & Shells

ON VIBRATIONS OF CYLINDRICAL SHELLS OF ELLIPTIC CROSS-SECTION. G. Herrmann and I. Mirsky. Columbia U. Inst. Flight Struc. TN 5 (AFOSR TN 57-734) [AD 136721], Dec., 1957. 22 pp. Analysis for the effects of ellipticity of the cross-section on the frequency of free vibration of constant thickness cylindrical shells. It is shown that purely longitudinal motions are governed by a Mathieu equation and that the square of the frequency of a slightly elliptic shell with semi-axes a and b is the arithmetic mean of the squares of the frequencies of two circular shells with radii a and b, respectively. Purely torsional motion appears to be unaffected by ellipticity, while purely transverse motion (breathing mode) does not exist in elliptic cylinders. Flexural motions are studied by energy methods. It is found that in the absence of nodal lines parallel to the generator, the ellipticity increases the frequency considerably for shells of like cross-sectional area.

A SIMPLE METHOD OF MATRIC STRUCTURAL ANALYSIS. III - FLEXIBLE FRAME AND STIFFENED CYLINDRICAL SHELL ANALYSIS. Bertram Klein. IAS 26th Annual Meeting, New York, Jan. 27 - 30, 1958, Preprint 765. 11 pp. Members, $0.35; nonmembers $0.75. Extension of a previously presented method to cover the case of stiffened cylinders. Treatable loadings include those producing peak shear, such as in flexible frame problems, and those involving thermal stresses. Various structural irregularities may be accounted for - such as variable frame moment of inertia, tapered longerons, variable skin gage, cutouts, non-circular cylindrical shells, etc. A flexible frame problem is solved by the method for illustration purposes.

TWO-DIMENSIONAL PROBLEMS IN ELASTICITY INVOLVING DIFFERENT MEDIA. N. J. Hardiman. Lond. Math. Soc. Proc., Oct., 1957, pp. 584-597. Solution by complex potential methods of problems of isotropic elastic plates in a state of generalized plane stress, in which there are inclusions of a second isotropic elastic material. Solutions are given for a circular hole in an infinite plate with an annular reinforcement in which the inner boundary is unstressed, the plate being under (a) an all-round tension T at infinity, (b) a simple tension T at infinity; and when the inner boundary is under any prescribed edge stresses or displacements, the stresses at infinity being given.

Elasticity & Plasticity

THE DECAY OF WAVES IN ELASTIC SOLIDS. T. Y. Thomas. J. Math. & Mech., Nov., 1957, pp. 759-768. ONR-supported investigation of the decay in the strength of the irrotational and equivoluminal waves during propagation on the basis of the extended compatibility conditions. Differential equations are derived for both cases, and, by integration, the general theorem on wave decay is obtained. It is shown that for decay the wave surface must be a developable surface (not a plane) or a surface of positive curvature.

Plates

DESIGN OF CIRCULAR PLATES FOR MINIMUM WEIGHT. E. T. Onat, Walter Schumann, and R. T. Shield. ZAMP, Nov. 25, 1957, pp. 485-499. Army-sponsored development of design procedures derived from the theorems of limit analysis. Both built-in and simply supported edge conditions are considered and the plate is loaded by an arbitrary rotationally symmetric distribution of pressure. The designs obtained are absolute minimum weight designs for the sandwich plate, but the minimum is a relative one for solid or homogeneous plate.

Testing

THE BENDING STRESSES IN CANTILEVER PLATES BY MOIRE FRINGES. P. J. Palmer. Aircraft Eng., Dec., 1957, pp. 377-380. Application of a technique, giving directly the gradient at all points on model's surface, to cantilever plates, including those with nonuniform thickness, in order to provide an experimental solution to the stresses in thin solid wings of any shape and with varying thickness. The technique and apparatus are described and some resultant experimental fringe patterns are shown and analyzed.

Thermal Stress

STAN NAPREŻÉN WYWOŁANY W PRZESTRZENI SPREZYSTEJ DZIAŁANIEM CHWILOWEGO ŻRÓDŁA CIEPŁA. Witold Nowacki. Arch. Budowy Maszyn, No. 3, 1957, pp. 285-305. In Polish, with summaries in English and Russian. Analysis of the stress state in an elastic space and half-space due to the action of an instantaneous source of heat, and of the stress state in an inelastic half-space caused by a concentrated instantaneous heat source. The latter problem is solved by the method of reflections.

CREEP DEFORMATIONS OF RECTANGULAR FRAMES. F. W. French, Jr., S. A. Patel, and N. J. Hoff. Polytech. Inst. Bklyn., Dept. Aero. Eng. & Appl. Mech., PIBAL Rep. 340 (AFOSR TN 57-714) [AD 136707], July, 1957. 29 pp. Experimental investigation in which frames of 5052-0 aluminum alloy are subjected to loads at 500°F. The displacement velocities are measured and compared to the results of theoretical analyses. In the calculation the effects of the rigid end fittings, of the beam-column action, and of simultaneous elastic and steady creep deformations are taken into account while primary creep is disregarded.

Weight Analysis & Control

ESTIMATING STRUCTURAL BOX WEIGHT. L. D. Green and Joseph Mudar. Aero. Eng. Rev., Feb., 1957, pp. 48-50. WADC-sponsored development of a method employing a multiple station analysis to determine optimum weight, and presentation of an exponential curve which is a function of time, in order to estimate the actual structural box weight. The multiple station analysis treats the aerodynamic and the geometric parameters in an analytical manner in order to determine optimum weight, while the time function reflects the aircraft manufacturers' design practices and the changing state-of-art in aircraft construction.

THE MINIMUM WEIGHT OF A STRUCTURE PROTECTED AGAINST SHORT DURATION AERODYNAMIC HEATING BY MEANS OF THERMAL INSULATION. R. A. Dobbins. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 773. 14 pp. Members, $0.50; nonmembers, $0.85. Formulation as a boundary value problem of the transient aerodynamic heating of an insulated metallic panel with adiabatic wall temperature and film coefficient as arbitrary functions of time. The means for determining the insulation thickness for a given panel temperature rise are discussed. A design of a wing upper panel in axial compression from air and thermal loads is considered. A structural weight penalty figure of demerit is then defined which includes the effects of (a) the loss of strength properties in structural materials with increasing temperature and (b) the occurrence of thermal stresses because of transient heating. A total weight penalty is found by considering the weight of insulation required to control the panel temperature. The analysis leads to an optimum design in terms of thickness of insulation, choice of structural alloy, and final panel temperature.

Wings

TERMOELASTODINAMICA DELLE ALI A GUSCIO. Paolo Santini. L'Aerotecnica, Aug., 1957, pp. 201-208. In Italian. Analysis of the thermoelastic behavior of wing structures, when inertia forces due to elastic displacements have to be taken into account. A method for the solution of the problem is presented along with tables, graphs, and a numerical example.

THERMODYNAMICS

Combustion

THE THICKNESS OF LAMINAR FLAMES IN PRE-MIXED REACTANTS: OPTICAL CONSIDERATIONS. F. J. Weinberg. Royal Soc. (London) Proc. Ser. A, Dec., 1957, pp. 107-118. 13 refs. Discussion of flame thickness and the necessary criteria for its definition and measurement. Owing to ray deflections occasioned by the flames refractive index fields, the apparent thicknesses of luminous zones are always part optical illusion. Expressions in terms of burning velocity, flame geometry and physical properties of the reactants are derived for the apparent thickness of an idealized luminous zone of no real thickness, and numerical values are deduced for typical flames used in combustion research. Their similarity to measured values leads to the conclusion that, at normal pressures, such

measurements do not, in general, furnish a true measure of luminous flame thickness. Simple optical methods of measuring flame thickness according to various definitions are presented, the theory is discussed, and their use illustrated by sample results.

SUR LE RENDEMENT DES FUSEES ET LE POUVOIR ENERGETIQUE DES ERGOLS. P. Glansdorff, A. Jaumotte, and J. Passelecq. (Congrès Internatl. Fusées & Engins-Guidés, Paris, Dec. 3-8, 1956.) Fusées, July, 1957, pp. 205-212. 11 refs. In French. Description of a direct method for determining the balance of continuous free thermodynamic systems and application to rocket regimes. The method permits the determination of the energy efficiency for uniform and accelerated motion. The maximum-work value derived contains the classical Maxwell-Gouy term, representing the available energy. Numerical values for various ergols in current use are given and it is shown that in combustion systems considered the Maxwell-Gouy term cannot be modified as in ordinary combustion reactions.

Heat Transfer

ON A PROBLEM OF HEAT CONDUCTION WITH TIME-DEPENDENT BOUNDARY CONDITIONS. Tse-Sun Chow. ZAMP, Nov. 25, 1957, pp. 478-484. Derivation of the distribution of temperature in a homogeneous, isotropic cylinder when its initial temperature distribution is known and its boundaries are subjected to temperature fields which are arbitrary functions of time. The method consists of a substitution which reduces the nonhomogeneous time-dependent boundary conditions to homogeneous boundary conditions, and may be considered as an extension of the method used by Mindlin and Goodman in solving vibration problems with time-dependent boundary conditions.

SOLUTION OF THE TRANSIENT HEAT-CONDUCTION EQUATION FOR AN INSULATED, INFINITE METAL SLAB. J. H. Grover and W. H. Holter. Jet Propulsion, Dec., 1957, pp. 1, 249-1, 252. Navy-sponsored preparation of a graphical representation of the generalized solution as well as graphical representation of a simplified, approximate solution of sufficient accuracy for engineering use. From these curves the insulation required to protect a metal slab from hot gases is determined, and an illustrative example is given.

VTOL & STOL

TILT WING AIRCRAFT IN COMPARISON WITH OTHER VTOL AND STOL SYSTEMS. W. Z. Stepniewski. Helicopter Assn. Gt. Brit. J., Dec., 1957, pp. 299-331; Discussion, pp. 331-339. 12 refs. Discussion of the main design problems for a tilt wing aircraft and an analysis of various design parameters from the point of view of overall performance. Analysis also includes the rotor propeller combination in hovering and forward flight, transition, and stability and control. Conclusions show that to achieve better zero range payload characteristics at normal (hovering) gross weight, design should be optimized for VTOL performance, disregarding STOL aspects. The means of achieving good fuel consumption are the same as in fixed wing aircraft. However, in order to maintain acceptable propeller efficiency in cruise, power plants should permit a reduction in r.p.m. A brief description is also given of the Vertol 76 tilt-wing aircraft, powered by a Lycoming T-53 free turbine engine.

WATER-BORNE AIRCRAFT

THE MOTION OF A SIMPLE WEDGE ALONG THE WATER SURFACE. H. B. Squire. Royal Soc. (London) Proc. Ser. A, Dec., 1957, pp. 48-64. Analysis using linearized theory of two-dimensional flow for a stream past a simple wedge partly immersed in water. Results show that as the speed increases from zero, the immersion of the wedge increases to a maximum and becomes small at high speeds; the frictional drag increases to a maximum at the hump speed and falls to a constant value at high speeds.

WIND TUNNELS & RESEARCH FACILITIES

AUTOMATIC DATA REDUCTION EQUIPMENT FOR WIND TUNNELS. Appendix I - DETAILED OPERATION OF THE TYPEWRITER. Appendix II - DETAILED OPERATION OF THE CARD PUNCH BUFFER CIRCUIT. Appendix III - DETAILED OPERATION OF THE SCANNER. Appendix IV - DETAILED OPERATION OF THE SERIAL COUNTER. Appendix V - DETAILED OPERATION OF THE HAND SET SWITCH UNIT. G. C. Rowley. Gt. Brit., RAE TN MS.35, May, 1957. 42 pp. Review of the development since 1947 in the data recording equipment used in R.A.E. wind tunnels. The latest equipment now going into use is described in detail.

AEROBALLISTICS RANGE MEASUREMENTS OF THE PERFORMANCE AND STABILITY OF SUPERSONIC AIRCRAFT. H. R. Warren, R. J. Templin, and B. Cheers. IAS 26th Annual Meeting, New York, Jan. 27-30, 1958, Preprint 788. 19 pp. 14 refs. Members, $0.50; nonmembers, $0.85. Description of a method for measuring aircraft drag and stability characteristics in free flight. Histories of the test model's speed, attitude angles and lateral motion during the flight are obtained using light screens and yaw cards, while shock wave and flow behavior are observed with schlieren systems. Either a longitudinal or a lateral type of motion during the flight can be obtained by suitable adjustment to the model's ballast and its position in the launching sabot, thus enabling simplified methods of analysis to be used. Longitudinal and lateral dynamic and static derivatives so far obtained compare well with values obtained in high-speed wind tunnels and with large scale rocket launched free flight models.

Stability & Control

Wind-Tunnel Investigation of the Static Lateral Stability Characteristics of Wing-Fuselage Combinations at High Subsonic Speeds; Taper-Ratio Series. James W. Wiggins and Paul G. Fournier. *U. S., NACA TN 4174*, Oct., 1957. 25 pp. Test results showing the effect of taper ratio on the aerodynamic characteristics in sideslip of wing-fuselage combinations having wings with a sweep of 45° at the quarter-chord line, an aspect ratio of 4, and an NACA 65A006 airfoil section.

Wings & Airfoils

O Podsasyvaiushchei Sile Kolebliushchegosia Kryla v Dozvukovom Potoke. M. D. Khaskind. *Prikl. Mat. i Mekh.*, 1957, pp. 581–584. In Russian. Derivation of a formula for the drag force of a wing oscillating in a subsonic stream.

Grenzen des Tragflügelauftriebs. H. B. Helmbold. *Ing.-Arch.*, No. 4, 1957, pp. 273–277. In German. Study of the limits imposed on the circulation lift of wings by finite span. As a basis for the work, the original form of Prandtl's linearized quantitative equations and the data on the final state of the vortex sheet, rolled up far behind the wing, are utilized.

Aerodynamics of Nonuniform Flows as Related to an Airfoil Extending Through a Circular Jet. Scott Rethorst. (*IAS Natl. Summer Meeting, Los Angeles, June 17–20, 1957, Preprint 643.*) *J. Aero. Sci.*, Jan., 1958, pp. 11–28. 20 refs.

A Finite Vortex Method for Slender Wing-Body Combinations. George S. Campbell. *J. Aero. Sci.*, Jan., 1958, pp. 60–62. 10 refs. Application of a number of two-dimensional vortices to calculate aerodynamic loads on wing-body combinations.

Aeroelasticity

Torsional Vibrations of a Multi-Rotor System Having a Non-Linear Flexible Coupling. S. Mahalingam. *RAeS J.*, Nov., 1957, pp. 779–781.

K Postroeniiu Periodicheskikh Reshenii Avtonomnykh Sistem s Odnoi Stepen'iu Svobody. A. P. Proskuriakov. *Prikl. Mat. i Mekh.*, 1957, pp. 585–590. In Russian. Derivation of periodic solutions for autonomous systems with one degree-of-freedom using the small-parameter method applying van der Pol variables.

Ostsilliatsionnye Svoistva Kolebanii Prodol'no Szhatogo Sterzhnia. A. S. Kondrat'ev and Z. S. Chaikina. *Prikl. Mat. i Mekh.*, 1957, pp. 560–563. In Russian. Determination of oscillating characteristics of a vibrating, longitudinally compressed rod.

An Analogy Between the Flexural Vibrations of a Cone and a Disc of Linearly Varying Thickness. H. D. Conway. *ZAMM*, Sept.–Oct., 1957, pp. 406, 407.

Ob Ustoichivosti Dissipativnykh Sistem. G. K. Pozharskii. *Prikl. Mat. i Mekh.*, 1957, pp. 503–512. In Russian. Study of the stability of dissipative systems.

Detecting Resonant Frequencies in Complex Structures. Russell F. Thielman. *Mach. Des.*, Nov. 14, 1957, pp. 149–152. Discussion of three basic methods to detect resonant frequencies, and presentation of a phase-angle method making use of Lissajous figures to indicate the exact degree of resonance.

Aeronautics, General

The Oceans of the Air. Arthur E. Raymond. *Albert Plesman Memorial Lecture, 2nd, Delft, Sept., 1957.* 33 pp. Comments on traffic development, including the prediction (based on an extension of established trends) that air cargo could be boosted an additional 500 per cent in the next decade by the introduction of improved transport planes.

The Role of Air Transport in European Integration. D. Goedhuis. *J. Air Law & Commerce*, Summer, 1957, pp. 273–285. Discussion of the need for a centralized body to allocate routes for European airlines, and an analysis of certain proposals by Hymans and Wheatcroft for a body of this type.

Aufgaben und Arbeitsweise der Zentralstelle der Luftfahrtdokumentation (ZLD). H. J. Rautenberg. *Luftfahrttechnik*, Oct. 15, 1957, pp. 227, 228. In German. Description of tasks and functioning of the Zentralstelle der Luftfahrtdokumentation (ZLD).

Punched Cards as an Aid to Documentation. O. Gdaniec. (*DVL Bericht No. 24*, Apr., 1957.) *Gt. Brit., MOS TIL/T4794*, Aug., 1957. 24 pp. Discussion of the marginal punching card as an aid to documentation, and of its basic application to aeronautical research.

Airplane Design

The Arrow Revealed. *Aircraft* (Canada), Oct., 1957, pp. 30–32, 34. Discussion of the aerodynamic characteristics of the Canadian Avro Aircraft's supersonic fighter, and of its possible mission roles.

Special Issue: Business and Touring Aircraft. *Flight*, Oct. 11, 1957, pp. 575–600. *Partial Contents:* The Business—Aircraft World; Aeroplanes for the Executive Market. Aeroplanes

NOW... ALL COLORS...
REPRODUCE PERFECTLY
J.S.STAEDTLER MARS-LUMOCHROM DRP. GERMANY
MARS-LUMOCHROM
MARS-LUMOCHROM
MARS-LUMOCHROM
MARS - LUMO CHROM
makes possible an important new drafting technique. It's not just a colored pencil; it's a color-drafting pencil. Twenty-four colors—and every one reproduces perfectly. Lets you draft with as many colors as you need. Saves time, prevents mistakes.
• won't fade • won't smear • really waterproof
• erases perfectly • keeps finest point
Send for free sample
Other new Mars products include: the Mars-Pocket-Technico for field use, the Mars "Draftsman's" Pencil Sharpener with the adjustable point-length feature, and the efficient, clean Mars lead sharpener. All available – along with the established standards: Mars-Lumograph black graphite drafting pencils, Mars-Technico lead holder and leads, and Tradition-Aquarell painting pencils – at all leading engineering and drafting supply dealers.
J.S. STAEDTLER, INC. HACKENSACK, NEW JERSEY

or Agricultural Work; Equipment for an Expanding Industry. Current Types Reviewed.

Executive Aircraft in 1957. *Interavia*, July, 1957, pp. 700–706. Survey of current production aircraft capable of carrying three to twelve passengers.

Manned Rocket Aircraft. Frederick I. Ordway, III. *Missiles & Rockets*, Nov., 1957, pp. 71–78. Review of the first 30 years of rocket aircraft history.

Engine-Airframe Integration. L. F. Nicholson. *RAeS J.*, Nov., 1957, pp. 711–720; Discussion, pp. 720–726. Study of the problem from an aerodynamic point of view. Includes consideration of the interference between jet and airframe, problems of engine-airframe integration at high-speeds, the use of the propulsive jet to augment lift, general problem of jet lift in cruising flight, the use of the engine thrust to sustain flight at low speeds, and jet flaps.

The Research Airplane—Past, Present, and Future. Walter C. Williams and Hubert M. Drake. (*IAS Natl. Summer Meeting, Los Angeles, June 17–20, 1957, Preprint 750.*) *Aero. Eng. Rev.*, Jan., 1957, pp. 36–41.

3 Lichte Tactische Jagers. *Avia Vliegwereld*, Nov. 7, 1957, pp. 682–684. In Dutch. Description of three light tactical fighters including the Bréguet 1001 "Taon." Dassault "Etendard VI," and Fiat G. 91.

Les Avions Supersoniques. *Tech. & Sci. Aéronautiques*, Sept., 1957, pp. 123–134. In French. Review of different supersonic aircraft types, with details of design and performance characteristics.

Sowjetische MiG-19 Farmer im Vergleich zur Super Sabre. *Flugwelt*, Oct., 1957, pp. 673–766. In German. Comparison of design, dimensions, and estimated performance data on the Soviet Mig-19 Farmer with those of the Super Sabre.

NATO-Vergleichsfliegen für taktische Leichtbaujäger. *Flugwelt*, Oct., 1957, pp. 758–760. In German. Review and presentation of data obtained from flights of NATO Lightweight Strike Fighters.

Überschallinterceptor und Mischantriebjäger Saunders-Roe SR.53. *Flugwelt*, Oct., 1957, pp. 732–734. In German. Description of the supersonic interceptor and Saunders-Roe fighter SR.53.

Aeroflot's New Turbine Equipment. *The Aeroplane*, Nov. 8, 1957, pp. 674–677.

Aeroflot Springs a Surprise. *Interavia*, Sept., 1957, pp. 914, 915. Discussion of the four new Russian turbine-powered civil aircraft, with comments on Aeroflot's future operating program.

NATO Light Fighter Evaluation. I, II. John Fricker. *The Aeroplane*, Oct. 4, 11, 1957, pp. 518–523; 538–560. Report of recent technical trials (concerned mainly with stability, control, and performance) of five lightweight tactical strike fighter prototypes (Bréguet 1001 Taon, Dassault Etendard IV and VI, Fiat G.91, and Sud-Aviation Baroudeur).

Commercial Aircraft Airliners of the World. *Flight*, Nov. 1, 1957, pp. 673–724. Review, including cutaway drawings, of the world's commercial aircraft, with prominence being given to turbine-powered transports.

Complexity and Progress in Transport Aircraft. *The Aeroplane*, Nov. 8, 1957, pp. 683–685. Abridged. Graphical analysis of the technical and economic development of transport aircraft over the past 40 years.

The Medium-Range Jet Transport is Feasible—Both Economically and Technically. A. D. Riedler. *SAE J.*, Nov., 1957, pp. 52–54. Abridged. Discussion of block speed, climb and descent times, and landing distances for the Convair 880.

"Tu-104." *Tech. Lotnicza*, May-June, 1957, pp. 88–92. In Polish. Presentation of technical data on the Tu-104 aircraft.

The Dornier Do 27 Multi-Purpose Aircraft. *Interavia*, July, 1957, pp. 707–709. Presentation of design, structural, and performance characteristics, and discussion of civil and military applications of German STOL aircraft.

Air Conditioning & Pressurization

Air Conditioning in Aircraft. E. W. Still. *RAeS J.*, Nov., 1957, pp. 727–755. Discussion of the general requirements, taking into account such considerations as safety, differential pressure, weight saving, power and air supply, cooling, and humidity.

Leakage Rates from a Pressurised Aircraft at Altitude. L. R. Jenkins. *RAeS J.*, Nov., 1957, pp. 776–779. Description of flight tests made to verify a method of predicting pressure cabin leakage rates at altitude.

Cockpits

Complexity in the Cockpit. H. R. Foottit. *Aircraft* (Canada), Oct., 1957, pp. 62, 65, 68, 108–110. Argument for a new, simplified approach to cockpit compartment design.

A Method of Recording and Measuring Limits of Visibility from Cockpits of Civil Aircraft. P. J. Foley, K. B. Jackson, and D. O. Blake. *Can. Aero. J.*, Nov., 1957, pp. 310, 311. Development of a technique by which reliable measurements can be speedily made by relatively untrained personnel, and by which records for specific aircraft can be readily compared with standard requirements.

Landing Gear

An Undercarriage in Ultra-High Tensile Steel. I. G. F. W. McCaffrey. (*CAI Annual Meeting, Ottawa, May 27, 28, 1957, Preprint 7/2.*) *Ind. Aeronautics*, Nov., 1957, pp. 31–35.

Rollreibung auf spurbildender Fahrbahn. A. Kneschke. *Ing.-Arch.*, No. 4, 1957, pp. 227–243. In German. Study, using the mechanics of viscous media, of the rolling friction resulting from the direct contact of an elastic wheel and an elastic track.

New Tire for STOL-Type Aircraft May Permit Rough Field Landings. V. Frisby. *SAE J.*, Nov., 1957, pp. 74–76. Abridged. Description of high-flotation tires which can be deflated in flight for stowing after each take-off and reinflated for landing.

Windshields

Stretched Acrylic; A Transparent Glazing Material for High-Speed Aircraft. John G. Stansbury. *Aero. Eng. Rev.*, Jan., 1958, pp. 42–46, 56. 10 refs. Discussion of a glazing to improve shatter and craze resistance, reduce weight, and simplify edge attachment design.

Airports

New York's Airports Prepare for the Jet Age. James H. Winchester. *Interavia*, Sept., 1957, pp. 896–898. Review of the Port of New York Authority's expansion program, with emphasis upon the plans for the airport buildings.

The Fuel Servicing of Turbine-Powered Transports. C. S. Parker. *Esso Air World*, Sept.-Oct., 1957, pp. 35–40. Discussion of ways in which the airlines plan to meet new requirements for aircraft servicing procedures imposed by the transition to turbine-powered equipment. Attention is focused on "fire safety" considerations.

Aviation Medicine

Vertigo as a Cause of Pilot Error in Jet Aircraft. Brant Clark and Ashton Graybiel. (*Aero Med. Assoc., 28th Annual Meeting, Denver, May 7, 1957.*) *J. Av. Med.*, Oct., 1957, pp. 469–478. Study of some 137 pilots to record the occurrence of vertigo. The most frequently reported experience involved confusion with regard to the altitude and motion of the aircraft, but visual vertigo and geographical disorientation were also reported.

The Optimum Test Composites to Predict a Set of Criteria. Appendix—**Summary of Steps to Yield an Optimum Set of Predictor Composites for Multiple Criteria.** Robert L. Thorndike. *USAF PTRC RR TN 57–103 [AD 134224]*, July, 1957. 18 pp.

Human Factors in Space Flight. Arthur Kahn. *Missiles & Rockets*, Nov., 1957, pp. 81–84. Discussion dividing the human endurance problems of space-flight vehicles into four major categories: ecological, perceptual, personality, and human engineering.

The Pathologic Investigation of Aircraft Accident Fatalities. Frank M. Townsend. *NATO AGARD, 10th Aeromed. Panel, Paris, Apr. 2, 1957.*) *J. Av. Med.*, Oct., 1957, pp. 461–468. 15 refs. Study of selected cases to illustrate the use of pathological studies in defining the causes of fatal aircraft accidents.

The Biologic Response to Overpressure. I—Effects on Dogs of Five to Ten-Second Duration Overpressures Having Various Times of Pressure Rise. Donald R. Richmond, Mead B. Wetherbe, Rinaldo V. Taborelli, Thomas L. Chiffelle, and Clayton S. White. (*Aero Med. Assoc., 28th Annual Meeting, Denver, May 6, 1957.*) *J. Av. Med.*, Oct., 1957, pp. 447–460. 17 refs.

Man and His Thermal Environment. *Mech. Eng.*, Nov., 1957, pp. 1,029–1,036. Discussion in terms of factors in heat stress, the body as a heat exchanger, reaction to extreme heat and cold, exposure to infrared radiation, and histolic studies of burns.

Zur biologischen Wirkung der Kosmischen Strahlung (KS) in grossen Höhen. Jakob Eugster. *Raketentech. & Raumfahrtforsch.*, Oct., 1957, pp. 71, 72. In German. Discussion of the biological influence of cosmic radiation at high altitudes and presentation of various measuring and test methods.

Computers

Errors Caused by Tape Speed Variations in Analogue Data Recording on Magnetic Tape. Appendix—**Derivation of Expression for Replayed Signal in Presence of Record and Replay Flutter.** P. F. Dingwall and E. C. Voss. *Gt. Brit., RAE TN Instn.159*, Apr., 1957. 21 pp.

Ob Otsenke Elektronnykh Integriruiushchikh Ustroistv. B. Ia. Kogan. *Avtom. i Telemekh.*, Sept., 1957, pp. 841–846. In Russian. Comparison of three main types of electronic integrators.

The Distinction Beween the Logic of Computers and the Logic of Storage and Retrieval Devices. Mortimer Taube. *Documentation Inc. AFOSR TN 57–165 [AD 126458]*, Sept., 1957. 12 pp. Differentiations of both negative and positive nature; negative in that the identity of computers and computer logic with automata and the logic of automata in general is shown to be in error and positive in that the specific logic of storage and retrieval automata is shown to be the algebra of classes as distinct from the propositional calculus which is the logical instrument for the analysis of computers and computer circuits.

Trapped-Flux Superconducting Memory. J. W. Crowe. *IBM J. Res. & Devel.*, Oct., 1957, pp. 295–303. Tests on a memory cell based on trapped flux in superconductors. The short transition time of the trapped-flux cell indicates its possible use in high-speed memories.

An Analysis of the Operation of a Persistent-Supercurrent Memory Cell. R. L. Garwin. *IBM J. Res. & Devel.*, Oct., 1957, p. 304–308. Detailed discussion of a particular theoretical model which may prove to be useful for the design of large-scale memory and computing systems.

A Binary-Weighted Current Decoder. E. J. Smura. *IBM J. Res. & Devel.*, Oct., 1957, pp. 357–362. Discussion of a method for driving cathode-ray-tube deflection yokes from digital equipment, and application of this system to a printed-circuit-package assembly of a typical converter.

A Radiosonde Data Processing Computer. Appendix I, II—**Revised Form of the Incremental Series Equation.** Robert Payne. *Cook Tech. Rep.*, Oct., 1957. 25 pp. USAF-sponsored presentation of a computer for converting present radiosonde observational data to incremental record form.

Computer Representations of Engineering Systems Involving Fluid Transients. F. D. Ezekiel and H. M. Paynter. (*ASME Annual Meeting, New York, Nov. 25–30, 1956.*) *ASME, Trans.*, Nov., 1957, pp. 1,840–1,850. 19 refs. Description of methods for computer representations of various physical elements commonly used in hydraulic and pneumatic systems such as conduits, valves, and pumps.

System for Rapid Reduction of Telemetric Data. E. Donald Heberling. *IRE Trans., TRC Ser.*, May, 1957, pp. 23–25. Description of automatic telemetric data reduction equipment (being developed at the U. S. Naval Ordnance Lab., Corona, Calif.) including a high-speed analog to digital converter and a high-capacity magnetic tape recorder not currently available on the market.

Hybrid Analog-Digital Computing Systems. Max Palevsky. *Instruments & Automation*, Oct., 1957, pp. 1,877–1,880. Review of the principles of hybrid computers, revealing the value of the new, fast Multiverter as an information link and as an independent computing device.

Weapon System Requirements for Air Data Computers. A. K., Hammell. (*NavBuAer Symp. on Air Data, Buffalo, Sept. 24–26, 1957.*) *Aero. Eng. Rev.*, Jan., 1957, pp. 32, 35. Discussion of the requirements imposed upon a central air data system in terms of static accuracy and dynamic response. The requirements include information displayed to the crew and data for fire control systems using ballistic armament.

Education & Training

Engineering Education and Training by Industry. W. H. Arata, Jr. *Aero. Eng. Rev.*, Jan., 1958, pp. 25–27, 41. 27 refs. Outline of some of the aeronautical engineering educational programs currently being sponsored by the industry. A list of the available literature is included.

Electronics

Masers and Related Quantum-Mechanical Devices. I. G. E. Weibel. *Sylvania Technologist*, Oct., 1957, pp. 90–97. 10 refs. Review of the basic principles of maser devices. Considering the first quantum-mechanical behavior of single atoms or molecules, transitions resulting in the absorption or emission of radiation are then described.

The Maser. W. H. Culver. *Science*, Oct. 25, 1957, pp. 810–814. 22 refs. Presentation of a molecular amplifier for microwave radiation which can operate with very low internal noise, thus offering the possibility of greater ultimate sensitivities in the fields of radio astronomy, communications, and radar.

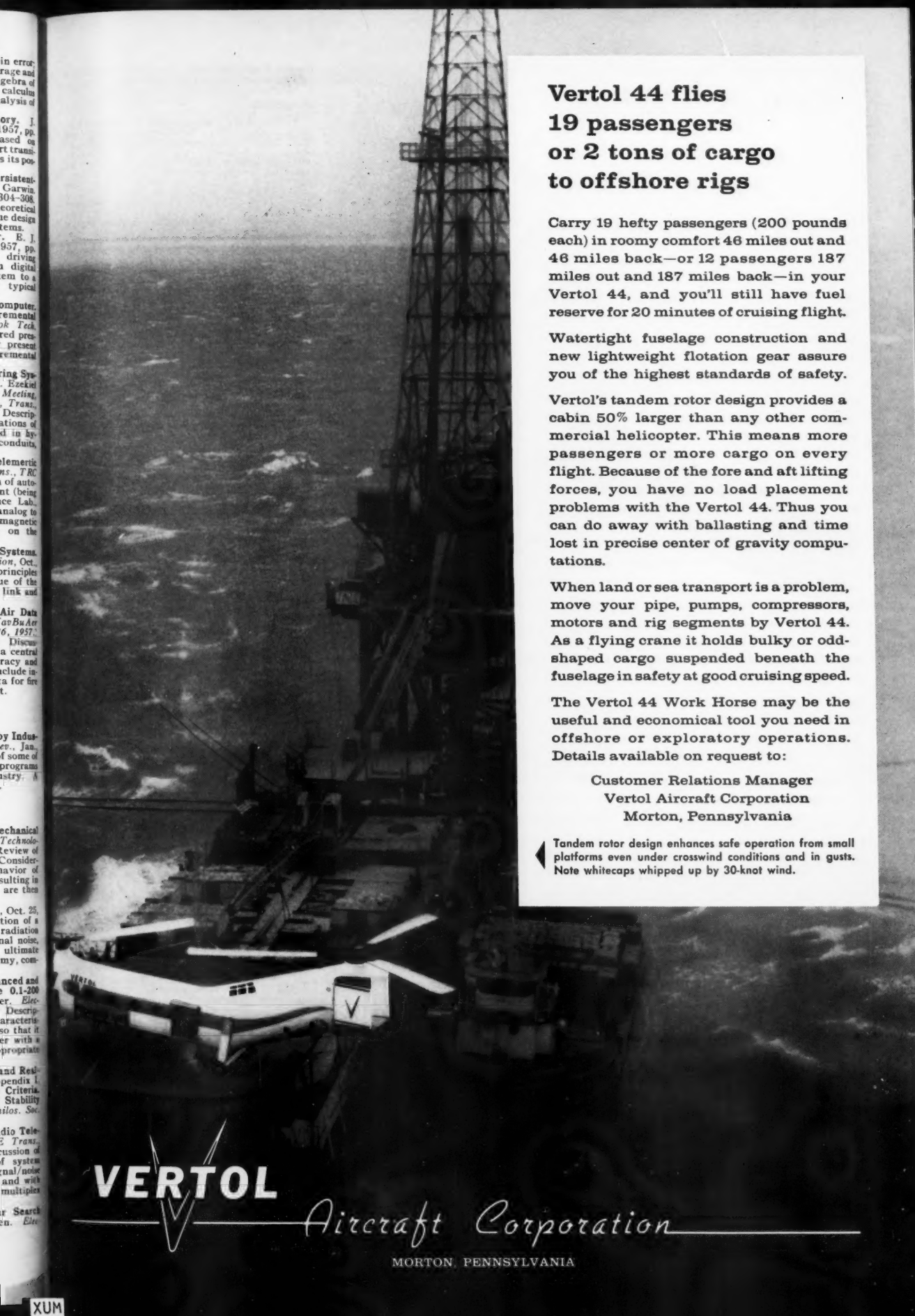
A Design Method for Wide Band Balanced and Screened Transformers in the Range 0.1-200 Mc/s. M. M. Maddox and J. D. Storer. *Electronic Eng.*, Nov., 1957, pp. 524–531. Description of a method in which the physical characteristics of the transformer are determined so that it appears as an ideal transformer together with a symmetrical low-pass filter with the appropriate iterative impedance.

Stability Criteria for Linear Systems and Realizability Criteria for RC Networks. Appendix I, II—**Presentation of the New Stability Criteria.** Appendix III—**Verification of the New Stability Criteria.** A. T. Fuller. *Cambridge Philos. Soc. Proc.*, Oct., 1957, pp. 878–896. 21 refs.

Noise and Bandwidth in FM/FM Radio Telemetering. Kenneth M. Uglow. *IRE Trans., TRC Ser.*, May, 1957, pp. 19–22. Discussion of the derivation, limitations, and use of system equations relating input and output signal/noise ratios in FM detection with band-pass and with low-pass output filters, and in FM/FM multiplex transmission.

Transistorized AFC Uses Triangular Search Sweep. H. H. Hoge and D. L. Spotten. *Elec-*

XUM



Vertol 44 flies 19 passengers or 2 tons of cargo to offshore rigs

Carry 19 hefty passengers (200 pounds each) in roomy comfort 46 miles out and 46 miles back—or 12 passengers 187 miles out and 187 miles back—in your Vertol 44, and you'll still have fuel reserve for 20 minutes of cruising flight.

Watertight fuselage construction and new lightweight flotation gear assure you of the highest standards of safety.

Vertol's tandem rotor design provides a cabin 50% larger than any other commercial helicopter. This means more passengers or more cargo on every flight. Because of the fore and aft lifting forces, you have no load placement problems with the Vertol 44. Thus you can do away with ballasting and time lost in precise center of gravity computations.

When land or sea transport is a problem, move your pipe, pumps, compressors, motors and rig segments by Vertol 44. As a flying crane it holds bulky or odd-shaped cargo suspended beneath the fuselage in safety at good cruising speed.

The Vertol 44 Work Horse may be the useful and economical tool you need in offshore or exploratory operations. Details available on request to:

Customer Relations Manager
Vertol Aircraft Corporation
Morton, Pennsylvania

Tandem rotor design enhances safe operation from small platforms even under crosswind conditions and in gusts. Note whitecaps whipped up by 30-knot wind.

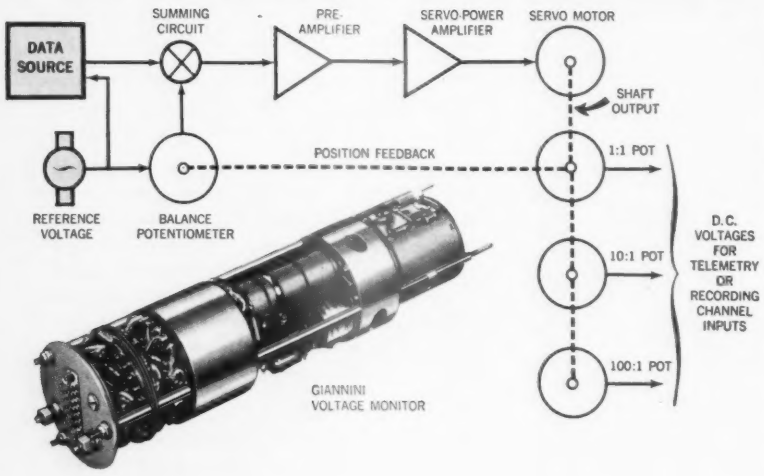
VERTOL Aircraft Corporation

MORTON, PENNSYLVANIA

XUM

For 0.035% Accuracy in your Airborne Data...

...Giannini DATA REPEATERS



GIANNINI PRECISION VOLTAGE MONITORS are Data Repeaters which utilize the scale multiplying technique. They have an inherent accuracy of 0.035% under all conditions, and repeatability of one part in ten thousand. This is the first time that such accuracy has been possible in a small (2¼" x 9") unit capable of withstanding the extreme environments of airborne operation.

THE PRECISION VOLTAGE MONITOR alters a transducer or control system signal so that data relayed to the telemetering or recording system is less susceptible to system errors. A unit designed for incorporation in the airborne telemetering system of Chance Vought's Regulus II results in telemetered data with approximately 0.04% overall error. This figure is conservative, and includes the effects of all unit error sources such as hysteresis, linearity, temperature effects, and long term drift, as well as telemetering system error.

A VOLTAGE MONITOR CONVERTS AC output signals from an airborne data source into 3 DC voltages, representing the data to four or more significant figures. These three separate units of information are fed into the telemetering or recording system on three separate channels. The result is transmitted information with an accuracy of four or five significant figures.

WITHOUT CHANGING THE CIRCUITRY of the transmitting system in any way, errors incurred in transmittal are restricted to the fourth or higher order significant figures.

Designed to satisfy the extreme environmental demands of aircraft and missile data systems, Giannini Precision Voltage Monitors are also readily adaptable to other airborne or industrial applications requiring precise voltage monitoring, data repeating, or data multiplexing. They are available in voltage ranges from 0.0 to 0.8v to 0.0 to 100.0v, and sizes from 2¼" x 6" to 2¼" x 9".

Giannini measures & controls:

ϖ	β	θ	ψ	τ	ν	φ
δ	Ω	α	h	P	ΔP	T
T_S	P_S	Q_C	M	T_0	P_T	TAS

PRECISION INSTRUMENTS SYSTEMS & CONTROLS

Giannini

G. M. GIANNINI & CO., INC., 918 EAST GREEN STREET, PASADENA, CALIF.

tronics, Nov. 1, 1957, pp. 178, 179. Description of a miniaturized plug-in unit for radar.

Amplifiers

Theory of the Ferromagnetic Microwave Amplifier. Appendix I—Effective Negative Q, and Gain-Band-Width Considerations. H. Suhl. *J. Appl. Phys.*, Nov., 1957, pp. 1,225–1,236. 17 refs. Discussion of all three possible types of operation using, respectively, two electromagnetic cavity modes, two sample modes, and one sample and one cavity mode. The case of a sphere in the first type of operation is treated separately.

O Postroenii Vkhodnykh Tsepei Elektronnykh Usilitelei Avtokompensatorov. D. E. Polonnikov. *Avtom. i Telemekh.*, Oct., 1957, pp. 911–917. In Russian. Discussion of the design of input circuits of electronic amplifiers and derivation of formulas to determine optimum transformation coefficient of the input transformation, taking into account the necessity of providing maximum sensitivity and maximum transfer coefficient.

Kharakteristiki Magnitnykh Materialov dlia Serdechnikov Magnitnykh Usilitelei s Povyshennoi Chastotoi Pitaniia. G. V. Subbotina. *Avtom. i Telemekh.*, Oct., 1957, pp. 927–933. In Russian. Description of magnetic characteristics used to design magnetic amplifiers at an increased supply frequency.

K Raschetu Tsepi Peremennogo Toka Magnitnogo Usilitelia. N. A. Kaluzhnikov. *Avtom. i Telemekh.*, Sept., 1957, pp. 792–801. In Russian. Development of a method for designing a magnetic amplifier, based on the "ideal" theory.

Antennas

Radiation Resulting from an Impulsive Current in a Vertical Antenna Placed on a Dielectric Ground. C. L. Pekeris and Z. Alterman. *J. Appl. Phys.*, Nov., 1957, pp. 1,317–1,323. USAF-supported research.

Anteny Lotnicze. Krzysztof Kunachowicz. *Tech. Lotnicza*, July-Aug., 1957, pp. 103–110. 12 refs. In Polish. Discussion of various aircraft aerial systems.

A New Technique in Ferrite Phase Shifting for Beam Scanning of Microwave Antennas. F. Reggia and E. G. Spencer. *IRE Proc.*, Nov., 1957, pp. 1,510–1,517. 12 refs. Development of a reciprocal ferrite phase shifter for 3-cm. wavelength which makes use of a new design technique for obtaining large phase changes per unit length by electrical means.

Circuits & Components

Transistor Switching Circuits. Mark Smith. *Electronic Des.*, Oct. 1, 1957, pp. 24–27. Application of transistors to a Schmitt trigger circuit and an Eccles Jordan circuit.

Principles of Filtering. I, II. L. S. Schwartz. *Electronic Des.*, Oct. 1, 15, 1957, pp. 20–23; 36–39. Discussion of the criterion and inverse probability method of receiver design. A description of comb filtering, linear integration, correlation, and synchronous detection is given, along with a discussion of autocorrelation radar.

Communications

Radio Aids for High-Speed Aircraft. *Tke Engr.*, Oct. 25, 1957, pp. 597, 598. Abridged. Discussion emphasizing the newer navigational aids, including the systems known as Tacan, Doppler, Dectra, and others dependent on stable frequency oscillators.

Construction Techniques

Micromation for System Miniaturization. Sidney Herman. *Missiles & Rockets*, Nov., 1957, pp. 154, 157, 158. Application of the micromation concept to typical computing, controlling, and indicating functions which are parts of more complex missile instrumentation systems.

Reliability and the Component Engineer. Robert W. Brown. *Elec. Mfg.*, Nov., 1957, pp. 126–129, 134, 135. Consideration of the component engineering specialist's role in providing applications engineering data to the circuit designer and packaging specialist.

Modules for Digital Instrumentation. Walter H. East. *Missiles & Rockets*, Nov., 1957, pp. 160, 162, 165. Discussion of basic modules capable of combining to form precision instruments as well as integrating with other instruments and machines to construct complete data handling and automation systems.

Cooling

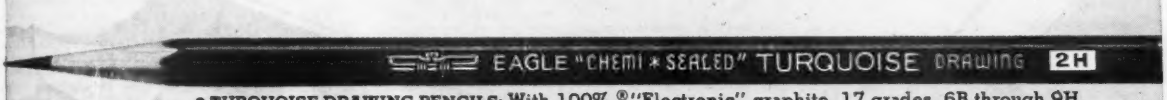
Design of Fins for Cooling of Semiconductors. Werner Luft. *Elec. Mfg.*, Nov., 1957, pp. 98–103. Use of semiconductors to illustrate the engineering approach to the design of fins for cooling.

Weight Flow Nomograms for High Altitude Air Cooling. J. Constant Van Rijn. *Electronic Des.*, Oct. 15, 1957, pp. XII–XVII.

Thermal Design. I, II. Harry M. Passman. *Electronic Des.*, Oct. 15, Nov. 1, 1957, pp. 26–29; 38–41. Discussion of techniques for thermal evaluation of commercial airborne electronic equip-

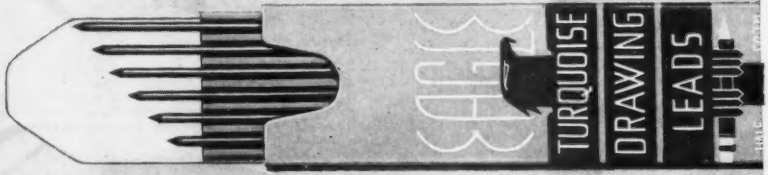
do your **drawings** do justice to your **designs?**

It takes a sharp drawing to sell a sharp idea —and you're halfway there when you pick up an EAGLE TURQUOISE drawing pencil. *No pencil on the market can match TURQUOISE for reproduction!* For one thing, TURQUOISE is tops for uniform grading. 17 scientific formulas guarantee exactly the blackness you want—from every pencil, every time! You get a strong needle point that just won't crumble—and stays sharp for line after long line of unchanging width. You can't beat it for smoothness, either—thanks to Eagle's exclusive ®"Electronic" graphite. TURQUOISE makes your drawings look sharp—and *you, too!*



• **TURQUOISE DRAWING PENCILS:** With 100% ®"Electronic" graphite. 17 grades, 6B through 9H.

• **TURQUOISE CLEANTEX ERASER:** Super-soft, non-abrasive rubber.



• **TURQUOISE DRAWING LEADS:** Fit any standard holder. Grades 5B through 9H.

• **TURQUOISE LEAD HOLDERS:** Hold any grade of Turquoise lead—so firmly that lead cannot be pressed back.

EAGLE ® TURQUOISE

PENCILS, LEADS AND HOLDERS

are the largest-selling in the United States!

EAGLE PENCIL COMPANY • NEW YORK • LONDON • TORONTO • MEXICO • SYDNEY • BOGOTA

ment. Design improvements include the following: use of improved tube shields; proper grouping of components-zones of desirability concept; and proper individual location of components.

Heat Exchange System Design for Airborne Electronics. F. P. Behning and J. P. Jacob. *Western Av.*, Oct., 1957, pp. 28, 30, 34. Discussion of recently developed techniques for the design of electronic equipment utilizing sub-miniature components, as well as compact arrangement techniques, resulting in high heat dissipation per unit volume.

Electronic Tubes

Tube Developments for Guided Missile Applications. R. W. Slinkman. *Sylvania Technologist*, Oct., 1957, pp. 102–105. Discussion of problems and their solutions for high ambient temperature and severe mechanical vibration, together with circuit requirements such as highly operating characteristics, high electrode potentials and low warm-up time.

Measurements & Testing

Potentiometers. Hugh Johnson. *Missile Des. & Devel.*, Nov., 1957, pp. 20, 21. Selection and use of potentiometers in missile electronic systems.

Difference Counters. A. F. Fischmann. *Electronic Eng.*, Nov., 1957, pp. 546–550. 16 refs. Discussion of some applications of a device for counting the difference in number between two sequences of pulses inserted at two different input terminals. Two practical examples are given, each being designed for a different speed.

Oscillators & Signal Generators

Designing Oscillators for Greater Stability. Samuel N. Witt, Jr. *Electronics*, Nov. 1, 1957, pp. 180–182. Method that permits selection of proper geometry and elements of the frequency-controlling network.

Über eine besondere Klasse selbsterregter Schwingungen. K. Klotter and E. Kreyszig. *Ing.-Arch.*, No. 6, 1957, pp. 389–403. In German. Consideration of the van der Pol differential equation describing the behavior of a certain class of self-excited oscillators with one degree of freedom.

Power Supplies

Design of Transistor Regulated Power Supplies. R. D. Middlebrook. *IRE Proc.*, Nov., 1957, pp. 1,502–1,509. Presentation of a new form of transistor series regulated power supply which permits unusually good performance characteristics with simple and economical circuitry.

Performance Guide for 400 c/s and 1600 c/s Joint Service Transductors. *Gt. Brit., RAE TN E1.141*, May, 1957. 71 pp.

Semiconductors

What's Ahead in Semiconductors. Robert Willardson. *Mil. Electronics*, Oct., 1957, pp. 16–18, 20, 22. Appraisal of the semiconductor, situation, present and future, including discussion of such new developments as devices utilizing the galvanomagnetic effects in germanium; infrared as a method of detecting enemy tanks, gun replacements, and aircraft; and semiconducting compounds for use in infrared optics and detecting systems.

Semiconductor Compounds Open New Horizons. Abraham Coblenz. *Electronics*, Nov. 1, 1957, pp. 144–149. Survey of semiconducting compound which gives the characteristics, unusual properties, and applications.

Poluprovodniki i ikh Tekhnicheskie Primeneniia. A. F. Ioffe. *AN SSSR Vestnik*, Aug., 1957, pp. 15–20. In Russian. Discussion of semiconductors and their technical applications.

High-Speed Microwave Switching of Semiconductors. R. V. Garver, E. G. Spencer, and R. C. LeCraw. *J. Appl. Phys.*, Nov., 1957, pp. 1,336–1,338. Measurements of rise and decay times of microwave switching in the order of millimicroseconds. Included is a discussion of the apparent lack of residual processes in the germanium following the application of a switching pulse, and of the ability to switch higher rf powers by reducing the impurity concentration.

High-Frequency Semiconductor Spacistor Tetrodes. H. Statz, R. A. Pucel, and C. Lanza. *IRE Proc.*, Nov., 1957, pp. 1,475–1,483. 10 refs. Discussion of a new class of devices which avoid the limitations imposed by the relatively slow diffusion of minority carriers through the essentially field-free base regions of transistors.

Telemetry

Transistorized Time Multiplexer for Telemetering. J. M. Sacks and E. R. Hill. *IRE Trans., TRC Ser.*, May, 1957, pp. 26–30. Description of a multiplexer which develops a commutated PAM signal corresponding to the IRIG standard for time multiplexing of an FM/FM signal.

A Survey of Progress Reported During 1955 in Telemetry and Remote Control. Kenneth M. Uglow. *IRE Trans., TRC Ser.*, May, 1957, pp. 9–13. 102 refs. Discussion in terms of data processing and storage, digital transmission equipment, millivolt telemeter equipment, multiplexing methods and equipment, radio transmission, remote control, theory and analysis, transducers, and transistorized telemeter equipment.

Special Issue: Telemetry and Remote Control. (*Natl. Symposium on Telemetering, Proc., Philadelphia, Apr. 14–16, 1957.*) *IRE Trans. TRC Ser.*, Apr., 1957. 339 pp. 61 refs. *Partial Contents:* Phase Angle Analogs in Out-of-Sight Control Instrumentation, Curtis L. Parish. A Wide-Band Microwave Link for Telemetering, Raymond E. Glass. A Remote Control System for an Airborne Test Vehicle, Lyman Nickel. Flight Test Data System, G. Luecke. Telemetering System for X-17 Missile, J. A. Cox. Progress Report on a Solid State FM/FM Telemetering System, Edward Y. Politi. Operational Problems in Aircraft Telemetering, E. Shanahan. Application of Telemetry to Flight Testing, A. J. C. Dettbam. A Telemetry Automatic Reduction System-TARE II, E. T. Hatcher. Notation and Characteristics of Two-Level Codes, George Birkel, Jr. Pin Bandwidth Requirements, Frank Rock. Coding for Suppression of Noise and Interference in Airborne PCM Telemetering Systems, Henning F. Harmuth. Noise and Bandwidth in PDM/FM Radio Telemetering, K. M. Uglow. PCM Data Collecting and Recording System Designed for Airborne Use, P. Knight. Design of All Channel Ultra-Stable FM Discriminator, Sherman Rigby. Time Interval Telemetering System, Ned Wilde. PDM-PAM Conversion System, R. L. Kuehn and Walter T. Johnson.

Telemetering for Interplanetary Flight. E. H. Krause. *ISA J.*, Oct., 1957, pp. 478–480. Discussion of telemetering problems arising from long-distance, high-speed missile flight, and presentation of the case for civilian radiation warning via telemeter following atomic attack.

Telecontrol. Elliot L. Gruenberg. *IRE Trans., TRC Ser.*, May, 1957, pp. 5–8. Review of the development of telemetry, and outline of the distinguishing characteristics of the newer concepts. A possible extension of Telecontrol to remote experimentation is discussed.

Wave Propagation

Designing Tapered Waveguide Transitions. Bernard J. Migliaro. *Electronics*, Nov. 1, 1957, pp. 183–185.

Slalom Focusing. J. S. Cook, R. Kompfner, and W. H. Yocom. *IRE Proc.*, Nov., 1957, pp. 1,517–1,522. Presentation of a backward-wave oscillator and a beam tester which utilize a "slalom" type focusing structure consisting of an array of positive wires sandwiched between two regular plates.

Equipment

Shock Testing Procedures and Equipment. C. A. Mills. *Environmental Quart.*, 4th Quart. 1957, pp. 4–7, 19, 23–27. Presentation of a brief history of shock testing, plus a description of current devices and techniques.

Electric

The Mechanism of the Leclanché Cell. J Euler. (*Z. für Electrochemie*, No. 9/10, 1956, pp. 1,056–1,063.) *Gt. Brit., RAE Lib. Transl. 668*, Aug., 1957. 14 pp. 13 refs.

Hydraulic & Pneumatic

Devise Pneumatic System for Temperature Control. Edmund Jachacz. *Ind. Labs.*, Nov., 1957, pp. 51–54. Presentation of a pneumatically and mechanically operated system utilizing a high thermal expansion material to sense temperature changes.

Hi-Pressure Pneumatics. H. E. Wright. *Western Av.*, Nov., 1957, pp. 10–14. Discussion indicating that, due to advancing technological changes and improvements, increasing numbers of designs of the future will utilize closed, high-pressure pneumatic systems where these systems prove themselves superior to other energy sources.

Probleme der berührungsfreien Hochdruck-Stopfbuchsen. K.-H. Groddeck. *Forschung Gebiete Ing., Ausg. A*, No. 5, 1957, pp. 183–195. In German. Investigation of the flow phenomena occurring in the vortex chambers of non-touching labyrinth seals leading to the formulas for the calculation of the flow velocities at the inlet of the sealing slits.

Luftfahrthydraulik—Stand und Tendenz der internationalen Entwicklung. E. Schumacher. *Luftfahrttechnik*, Sept. 15, 1957, pp. 205–216. In German. Consideration of the hydraulic systems and problems of development.

Packaged Hydraulics. Thomas F. Fitzgibbon and William Margraves. *Western Av.*, Oct., 1957, pp. 16–20. Discussion of packaged hydraulic systems aimed at the reduction of total system complexity, permitting savings in cost, volume, weight, and maintenance. As military units, an added factor of lesser vulnerability and greater reliability is also gained.

Torque and Flow Characteristics of a Butterfly Valve Operating at Pressure Ratios Above the Critical. A. H. Robinson. *Gt. Brit., NGTE Memo. M304*, July, 1957. 22 pp.

Fluides de Transmission en Aéronautique. F. Meiller and F. Reynaud. *La Recherche Aéronautique*, Sept.-Oct., 1957, pp. 41–45. In French. Consideration of transmission fluids (type FH4 or FH8G4) in relation with actual equipment or the study of new aircraft, when the temperatures due to kinetic heating exceed the actual limits of safe operation.

Flight Testing

Dynamic Response Characteristics of the C-130 Airplane as Determined During Phase IV Flight Tests, with an Evaluation of the Test and Analysis Procedures. Carl Simmons and Wilbur A. Ballentine. *USAF FTC TN 57-18 [AD 131448]*, Sept., 1957. 73 pp.

Elaborazione Meccanografica di Dati di Prove di Volo. Giulio Ciampolini and Bruno Provero. *France, ONERA, J.I.S.A., Paris, May 27–29, 1957, Comptes Rendus, Pt. 2*, pp. 41–49. In Italian. Study of technical and organizational problems encountered during the application of automatic computation to flight-test data.

Fuels & Lubricants

High-Energy Fuels. D. R. Geehring. *Ordnance*, Nov.-Dec., 1957, pp. 563–566. Discussion of such fuels as hydrogen, free radicals, and boron compounds, with emphasis on the development of the latter.

Effect of Lubricant Viscosity on Rolling-Contact Fatigue Life. Thomas L. Carter. *U.S., NACA TN 4101*, Oct., 1957. 25 pp. 12 refs. Test results which indicate that rolling-contact fatigue life is a function of approximately the 0.2 power of lubricant viscosity.

Trends in Lubrication. R. O. Campbell and S. C. M. Ambler. (*CAI Annual Gen. Meeting, Ottawa, May 27, 28, 1957, Preprint 716.*) *Can. Aero. J.*, Nov., 1957, pp. 305–309. 11 refs.

Investigation of Hydrofluoric Acid as a Corrosion Inhibitor for Fuming Nitric Acids. M. J. Keeler and E. F. Knoll. *USAF WADC TR 56-310 [AD 110504]*, (Jan., 1957) Nov., 1956. 165 pp. Investigation revealing that corrosion rates of 6061–T6 aluminum and type 347 stainless steel are generally reduced by a factor varying from about 10 to 100 when an initial hydrofluoric acid content of approximately 0.75 per cent by weight is employed.

Gliders

Przybliżona Analiza Korkociągu Szybowca. Władysław Nowakowski. *Tech. Lotnicza*, May-June, 1957, pp. 71–75. In Polish. Presentation of an approximate analysis of the spin of a glider.

Ice Formation & Prevention

Fuel System Icing. D. T. McAllan and G. Reynard. *Air BP*, No. 4, 1957, pp. 21–23. Review of the problem of eliminating water from fuel delivered to aircraft, including discussion of various solutions.

Aircraft Gas Turbine Ice Prevention—The Design and Development of Hot Air Surface Heated Systems. C. K. Rush and D. Quan. (*CAI Annual Gen. Meeting, Ottawa, May 27, 28, 1957, Preprint 7/10.*) *Can. Aero. J.*, Nov., 1957, pp. 318–324.

Instruments

Les Instruments de Bord Hermétiques. M. Bourrand. *Tech. & Sci. Aéronautiques*, Sept., 1957, pp. 143–146. In French. Analysis of sealed aircraft instruments. The principal manufacturing difficulties are outlined.

External Interference Effects of Flow Through Static-Pressure Orifices of an NACA Airspeed Head at a Mach Number of 3. Norman S. Silsby. *U.S., NACA TN 4122*, Oct., 1957. 12 pp. Wind-tunnel tests with results indicating that the static-pressure error increases almost linearly with increase in mass flow through the orifices.

A Sensitive Aerodynamic Drag Balance as an Indicator of Low Air Speeds. J. F. Kemp. *J Sci. Instr.*, Oct., 1957, pp. 411–415. Description of construction and performance characteristics of a low air-speed indicator, which can be used as standard of comparison for routine calibration of anemometers in a wind tunnel.

A New Stable Platform for Today's Aircraft Today. J. F. Schoeppel. *Aero. Eng. Rev.*, Jan., 1957, pp. 50–56. Description of a two-gyro, all-attitude master reference system. This system serves as a transition link between conventional aircraft gyros and precision miniature stable platforms.

Automatic Control

Signal Stabilization of a Control System. Rufus Oldenburger. (*ASME Annual Meeting, New York, Nov. 25–30, 1956.*) *ASME Trans.*, Nov., 1957, pp. 1,869–1,872. Presentation of a method by which linear, automatically controlled systems, with two or more dominant lags may be stabilized by the introduction of noise, or a signal of sufficiently high frequency, or a signal with sufficiently

high-frequency components, provided that the hunt of the system is not excessively severe.

The Influence of Coding on Closed Loop Remote Control Systems. Zeev Bonenn. *IRE Trans., TRC Ser.*, May, 1957, pp. 16–19. Discussion indicating that various simple coding methods create stability problems and require better observation. Command and observation channels requirements are compared and it is shown that a compensatory relationship exists between them.

Sposob Polucheniia Slozhnykh Zakonov Regulirovaniia s Ispol'zovaniem lish Signala Oshibki ili Reguliruemoi Koordinaty i ee Pervoi Proizvodnoi. S. V. Emel'ianov. *Avtom. i Telemekh.*, Oct., 1957, pp. 873–885. In Russian. Development of a method for obtaining complicated laws of control using only an error signal and its first derivative.

O Vliianii Nekotorykh Nelineinykh Kharakteristik Elementov Izodromnogo Reguliatora na Dinamicheskie Svoistva Sistemy Avtomaticheskogo Regulirovaniia. E. K. Krug and O. M. Minina. *Avtom. i. Telemekh.*, Oct., 1957, pp. 886–898. In Russian. Analysis of the influence of nonlinear characteristics of some elements of P. I. controller on the transient properties of an automatic control system.

Nelineinye Preobrazovateli s Odnim Vkhodom. L. V. Medvedev, A. A. Fel'dbaum, and L. N. Fitsner. *Avtom. i Telemekh.*, Oct., 1957, pp. 899–910. 11 refs. In Russian. Development of a method for designing an electronic nonlinear function generator with one input. Fields of their application are pointed out.

Schwingungen in einem unstetigen Temperatur-Regelkreis mit Totzeit. K. Magnus. *Forschung Gebiete Ing., Ausg. A*, No. 5, 1957, pp. 169–175. In German. Study of oscillations occurring in an unsteady temperature control loop with time delay.

Primenenie Radioaktivnykh Izluchenii v Ustroistvakh Avtomaticheskogo Kontrolia. Iu. V. Gushchin, L. V. Mel'ttser, M. I. Tolokonnikov, and N. N. Shumilovskii. *Avtom. i Telemekh.*, Sept., 1957, pp. 814–840. 48 refs. In Russian. Discussion of methods and trends of using radioactive radiation in automatic control devices. Includes description of some practical applications.

Design Basis for Cascade-Type Positional Servomechanisms. Sidney Lees and T. C. Blaschke. (*ASME Annual Meeting, New York, Nov. 25–30, 1956.*) *ASME Trans.*, Nov., 1957, pp. 1,873–1,896. Extension of a previously developed design basis to the coordination of specifications, dynamic characteristics, interferences, and uncertainties from a consideration of the generation of torques by a cascade-type system.

Analiz Dvizheniia Nagruzhennogo Gidravlicheskogo Ispolnitel'nogo Mekhanizma s Obratnoi Sviaz'iu. V. A. Khachlov. *Avtom. i Telemekh.*, Sept., 1957, pp. 773–780. In Russian. Analysis of motion of a loaded hydraulic servomotor with a rigid feedback.

Flow Measuring Devices

The Leon Tube: An Instrument for Measuring Flow Speeds in Water. J. F. Kemp. *J. Sci. Instr.*, Oct., 1957, pp. 390–392. Description of the construction and performance characteristics of a robust, compact tube capable of measuring flow speeds in water "at a point" over a range of 1 to 14 ft./sec. The instrument has proved to be particularly suitable for the performance of velocity traverses in open channels.

Temperature Measuring Devices

High-Temperature Measurements. H M. Beede. *Instruments & Automation*, Oct., 1957, pp. 1,896,–1,898. Description of the problems associated with measurement of high temperature gas, and recommendation of a development program.

Vibration Measuring Devices

Excitateurs et Capteurs de Vibrations à Système Compensateur de Masse et Raideur. H. Loiseau. *La Recherche Aéronautique*, Sept-Oct., 1957, pp. 23–27. In French. Description of vibration exciting and recording devices and of improvement of their operation and applications.

Laws & Regulations

Law Must Precede Man into Space. Andrew G. Haley. *Missiles & Rockets*, Nov., 1957, pp. 67–70. Analysis based upon practical methods of formulating the jurisdiction of air space suggested by von Kármán.

Problems of Law in Civil Aviation. James R. Durfee. *J. Air Law & Commerce*, Summer, 1957, pp. 323–333. Discussion of the separate powers of the Civil Aeronautics Administration and the Civil Aeronautics Board, and how these powers are administered.

Medico-Legal Problems in Civil Aviation; a Study of Divided Jurisdiction over Physical Standards for Airmen Under the Civil Aeronautics Act of 1938. Stanley J. Aronoff and David A. Talman. *J. Air Law & Commerce*, Summer, 1957, pp. 304–322. 134 refs.

Space Law and Metalaw-Jurisdiction Defined. Andrew G. Haley. (*ARS Spring Meeting,*

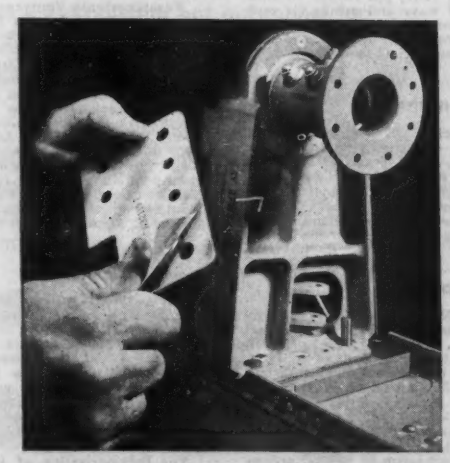
Aircraft Assembly Engineers prove it:

LAMINATED SHIMS OF

LAMINUM®

SURFACE BONDED... THEY *peel* FOR ADJUSTMENT

SAVE TIME! CUT COSTS!



With all laminations smoothly surface-bonded, LAMINUM looks and acts like solid metal, yet simply p-e-e-l-s for a thousandth fit—right at the job.

✓IN ALUMINUM
with laminations of .003"

✓IN STAINLESS STEEL
with laminations of .002" or .003"—also available in Mild Steel and Brass.

Newly published *Engineering Data File* contains detailed information. Write for your copy; there's no obligation.

LAMINATED SHIM CO., INC.
Shim Headquarters since 1913
9702 Union St., Glenbrook, Conn.

Wash., Apr. 3–6, 1957.) *J. Air Law & Commerce*, Summer, 1957, pp. 286–303. 32 refs. Discussion to achieve a scientific definition of the precise area where the jurisdiction of terrestrial law ends and the jurisdiction of space law begins.

Problems of Federalism in the Air Age. II. Eugene A. Weibel. *J. Air Law & Commerce*, Summer, 1957, pp. 253–272. 42 refs. Discussion of the legal cases arising from air traffic in and around New York City.

When is an Aircraft a "Nuisance" in the Eyes of the Law? Alastair R. Paterson. *CAI-IAS Joint Meeting, Montreal, Oct. 21, 22, 1957, Preprint 756.* 11 pp. Members, $0.35; nonmembers, $0.75. Discussion of some legal aspects of aircraft noise.

Machine Elements

An Analysis of the Effect of Several Parameters on the Stability of an Air-Lubricated Hydrostatic Thrust Bearing. William H. Roudebush. *U.S., NACA TN 4095*, Oct., 1957. 34 pp. Development of equations which indicate that higher temperatures reduce the weight flow and reservoir pressure required for a fixed load and clearance, and favor stable operation by making a softer bearing.

O Skachke Sily Treniia pri Ostanovke. D. M. Tolstoi and Pan' Bin'-Iaao. *AN SSSR Dokl.*, June 21, 1957, pp. 1,231–1,234. 11 refs. In Russian. Study of the difference between the forces of static and dynamic friction.

Hinged Gear Trains: An Answer to Shock, Temperature Change and Mounting Flexibility. Dominic P. Scotto. *ARMA Eng.*, Oct.-Nov., 1957, pp. 10–12. Discussion of suitable methods for evaluating the errors introduced into a practical gear train by various methods of construction, with emphasis on the comparison between conventional methods of construction and the pivoted gear box construction.

Kritische Drehzahlen gewisser Rotorformen unter Berücksichtigung der Kreiselwirkung. L. Fehrle. *Ing.-Arch.*, No. 5, 1957, pp. 319–329. In German. Study of the critical rotational speed of certain rotors taking into account the gyroscopic action.

How to Design High-Speed Rotating Parts for Maximum "Burst-Resistance." R. G. Anderson. *Mach. Des.*, Oct. 17, 1957, pp. 148–156. Discussion of the nature of centrifugal loading, and the influence of stress, strength, and ductility upon bursting speed.

Selection and Application of Dynamic Seals and Packings. John B. Holt and William S. Miller. *Mach. Des.*, Oct. 31, 1957, pp. 70–98. A comprehensive survey of ways and means for positive-contact sealing of moving shafts, including consideration of felt, radial, mechanical, and floating-ring seals, and compression, molded synthetic, and leather packings.

Maintenance

Daks Decks & Docks. *Air BP*, No. 4, 1957, pp. 6–8. Discussion of varied uses for Dexion Ltd.'s angle-sections, with special attention to their use for temporary repair of a U.B.A. Dakota.

Cold Weather Operations. Lloyd Wigle. *Ind. Aeronautics*, Nov., 1957, pp. 24–27, 30. Listing of cold weather preparations and operating instructions along with recommended remedies.

Materials

Simple Geometric Model for the Effect of Porosity on Material Constant. Ferdinand Euler. *J. Appl. Phys.*, Nov., 1957, pp. 1,342–1,345. 16 refs. Discussion of the implications of applying a theoretical model to the mechanism of sintering.

Special Issue: A Discussion on Work-Hardening and Fatigue in Metals. *Royal Soc. (London) Proc., Ser. A*, Oct. 29, 1957, pp. 145–227. 121 refs. *Partial contents*: Work-Hardening and the Initiation and Spread of Fatigue Cracks, N. F. Mott. The Mechanism of Work-Hardening and Slip-Band Formation, J. Friedel. The Energy Stored in Fatigued Metals, L. M. Clarebrough, M. E. Hargreaves, G. W. West, and A. K. Head. The Hardening and Softening of Metals by Cyclic Stressing, T. Broom and R. K. Ham. Annealed Metals Under Alternating Plastic Strain, W. A. Wood and R. L. Segall. The Initial Fatigue Crack, G. C. Smith. Slip-Band Damage and Extrusion, P. J. E. Forsyth. The Fatigue and Ultimate Tensile Strengths of Metals Between 4.2 and 293°K., R. D. McCammon and H. M. Rosenberg. Some Observations on the Spread of Fatigue Cracks, N. E. Frost and C. E. Phillips. Speed Effect in Fatigue, P. G. Forrest.

Corrosion & Protective Coatings

Hot-Dipped Aluminum Coatings. Herbert L. Kee. *Prod. Eng.*, Oct. 28, 1957, pp. 57–59. Development of an easier method of hot-dipping exhaust parts, which allows substitution of less-costly materials, lowers fabricating costs, and reduces maintenance.

Metals & Alloys

Etude des Phénomènes de Réversion dans les Alliages Légers Durcissants. René Graf. *La Recherche Aéronautique*, Sept.-Oct., 1957, pp. 47–56. 24 refs. In French. Study of the reversion phenomena of light hardening alloys. Special consideration is given to the AU4 alloy.

Selecting Structural Materials for Supersonic Flight. Donald D. Cox. (*IAS Natl. Summer Meeting, Los Angeles, June 17–20, 1957, 731.*) *Aero. Eng. Rev.*, Jan., 1957, pp. 28–31. Discussion of structural efficiency considerations for materials in an aircraft designed to fly in a given thermal environment.

PH 15-7 Mo: Mach 4, 1000°F Stainless Steel for Hi-Temp Aircraft. M. E. Carruthers. *Western Av.*, Oct., 1957, pp. 22–24, 26. Discussion of the new, thinner "super-steel" with increased steel strength, which overcomes the weight objection and meets advancing aircraft flight speed demands.

Precipitation Hardening Stainless Steels; Treatment and New Materials in the U.S. Aircraft Industry. Allen C. Gilbraith. *Metal Treat.*, Oct., 1957, pp. 395–399. Discussion of the properties and structure of 17-7PH, 17-4PH, and AM-350 steels under various heat treatment conditions.

Metals & Alloys, Nonferrous

Sand Cast Magnesium—Rare Earth Metal-Zirconium Alloys. T. E. Leontis and D. H. Feisel. *J. Metals*, Oct., 1957, pp. 1,245–1,252. 17 refs. Investigation of the effect of increasing amounts of zirconium on magnesium sand casting alloys containing several different rare earth metals in varying amounts.

Généralisation du Tampon Electrolytique pour la Métallographie; Cas de l'Oxydation Anodique des Métaux Légers. P.-A. Jacquet. *La Recherche Aéronautique*, Sept.-Oct., 1957, pp. 57–60. In French. Generalization of the electrolytic plug technique for its application in metallurgy. Includes the case of anodic oxydation of aluminum and its alloys.

Issledovaniie Staticheskoi Vynoslivosti Splavov Al-Zn, Al-Mg i Al-Cu. I. N. Fridliander, N. M. Edel'man, and Iu. S. Danilov. *AN SSSR Dokl.*, July 11, 1957, pp. 287–289. In Russian. Investigation of the static endurance of Al-Zn, Al-Mg, and Al-Cu alloys.

Tensile Deformation of Aluminum as a Function of Temperature, Strain Rate, and Grain Size. R. P. Carreker, Jr., and W. R. Hibbard, Jr. *J. Metals*, Oct., 1957, pp. 1,157–1,163. 21 refs. USAF-WADC-supported presentation of true stress, true strain data for two lots of high-purity aluminum annealed to produce several different grain sizes from each lot.

Vosstanovlenie Vnutrennego Treniia Chistogo Aliuminiia Posle Sniatiia Nagruzki. A. Ia. Samoilova and V. S. Postnikov. *AN SSSR Dokl.*, June 21, 1957, pp. 1,228–1,230. 18 refs. In Russian. Restoration of internal friction in pure aluminum after relief of load.

Study of the Initiation and Development of Fatigue Cracks. Gunnar Wallgren. (*Sweden, Flygtekniska Försöksanstalten, Rep. HU-569*, Oct., 1955.) *Gt. Brit., RAE Lib. Transl. 677*, July, 1957. 31 pp. Tests in which comparison of 0 to 8 and 4 to 12 kg./mm.^{2} oscillating loads in tension results in about 50 per cent reduction in life. Tests to determine the load to increase crack length are given, along with tests to determine the maximum stress at which the crack will not develop further.

Nonmetallic Materials

Paper, Plastics and Weight-Saving. I, II. George May. *The Aeroplane*, Nov. 1, 8, 1957, pp. 650–653; 686–689. 15 refs. Discussion of the development work in producing Dufaylite honeycomb, and applications to aircraft.

Investigation into the Electrochemical Behaviour of O_2-H_2O_2-H_2O at Smooth and Platinised Platinum. D. Winkelmann. (*Z. für Elektrochemie*, No. 7, 1956, pp. 731–740.) *Gt. Brit., RAE Lib. Transl. 687*, Aug., 1957. 22 pp. 14 refs.

The Polymerisation of Phosphonitrilic Chlorides. II—Some Derivatives of the Trimer. F. G. R. Gimblett. *Gt. Brit., RAE TN Chem. 1312*, July, 1957. 13 pp. 11 refs.

Eksperimental'noe Issledovanie Zavisimosti Skorosti Vysokoelasticheskogo Razryva ot Skorosti Deformatsii Obraztsa. V. E. Gul' and G. P. Krutetskaia. *AN SSSR Dokl.*, June 11, 1957, pp. 973–979. In Russian. Experimental investigation of highly elastic polymer specimens in order to determine the relation between the rate of their rupture process and the rate of deformation.

The Resistance of Glass Fiber Reinforced Laminates to Weathering. Lucius Gilman. *SPE J.*, Nov., 1957, pp. 33–38. Review and interpretation of available data.

Flexural Properties of 181 Glass Cloth Laminates. W. R. McGlone. *SPE J.*, Oct., 1957, pp. 30–34. Discussion of the effect of fiber location on the flexural properites of two different types of four-ply layups, and demonstration of how the flexural strength and elastic modulus in bending varies with the resin content.

Evaluation of Anti-Wear and Extreme Pressure Characteristics of New Heterocyclic Compounds. Appendix I—Immediate Seizure and Weld Test. Robert J. Benzing. *USAF WADC TR 57-283 [AD 130902]*, July, 1957. 10 pp. Analysis of a series of nineteen compounds in Di (2-ethylhexyl) sebacate in the Shell Four-Ball Wear Tester and Shell Extreme Pressure Tester.

Designing with Teflon. IV—Methods of Fabrication. *Mach. Des.*, Oct. 17, 1957, pp. 124–130.

Warmfeste Kunststoffe für den Luftfahrzeugbau. R. W. Schulz. *Luftfahrttechnik*, Oct. 15, 1957, pp. 218–223. 16 refs. In German. Discussion of fiberglass resin structures for aircraft surfaces subject to aerodynamic heating, and description of production techniques and test data.

Electrical Conductivity of Plexiglas. R. J. Munick. *J. Appl. Phys.*, Nov., 1957, pp. 1,302–1,303. 12 refs. Test results indicating that conduction through Plexiglas at weak fields is primarily by ions.

Zur Verwendung von Kunststoffen in der Rakete ntechnik. Alfred J. Zaehringer. *Raketentech. & Raumfahrtforsch.*, Oct., 1957, pp. 57–59, 77. In German. Discussion of the use of plastics in rockets, as raw materials for the construction of airframes, as combustibles, and adhesives for the use in electronic and other instruments.

Reinforced Plastic Reflectors. Ralph L. Mondano. *SPE J.*, Oct., 1957, pp. 52, 53. Presentation of solutions to the problems encountered by plastics engineering researchers in the development of a radar reflector which is rigid, dimensionally exact, and able to hold metal attachments and reflect radar.

Testing

Note on the Chemical Analysis of Lead Materials. R. Collee. (*Anal. Chim. Acta*, No. 14 1956, pp. 430–438.) *Gt. Brit., RAE Lib. Transl. 688*, Oct., 1957. 11 pp.

Fatigue Tests on Glass-Fibre-Reinforced Plastics. N. G. Calvert. *The Engr.*, Oct. 11, 1957, pp. 522, 523. Test results indicating that specimens treated statically under corresponding conditions of loading are liable to fatigue, with a fatigue limit strength on a 50,000,000 cycle base of approximately 12 per cent of the static strength.

A Review of Sonic Methods for the Determination of Mechanical Properties of Solid Materials. C. E. Kesler and T. S. Chang. *ASTM Bul.*, Oct., 1957, pp. 40–46. 39 refs. Discussion of various sonic methods, including the main advantages and disadvantages of each.

Creep of Glass-Reinforced Plastics. S. Goldfein. *ASTM Bul.*, Oct., 1957, pp. 29–36. 13 refs. Development of a method of determining the creep properties of glass-reinforced plastic laminates by short-time or static tests of their properties at temperatures up to 500°F.

A Fixture for Compression Testing of Sheet Materials at Elevated Temperatures. B. L. Molander, C. R. Waldron, and J. C. Newland. *ASTM Bul.*, Oct., 1957, pp. 37–39. Development of a device that reduces high-temperature factors to a minimum, inhibits buckling, and eliminates maintenance trouble and unreliable data caused by friction at high temperatures.

Contributii la Studiul Formei Zoeni Gituite la Epruvetele Metalice Supuse la Tractiune. A. Bernath and M. Ratiu. *Stud. Cerc. Stiint.*, July-Dec., 1956, pp. 41–86. 16 refs. In Rumanian. Results of a study with various metal samples subjected to torsion.

Measurement of Adhesive Moduli. P. F. Tapp, A. Broodo, C. E. Horn, and S. V. Castner. *Aircraft Eng.*, Nov., 1957, pp. 350–352. Determination of the elastic and viscous moduli of adhesive-bonded rods by an ultrasonic method. The results are compared with the tensile strength of the bonds.

Mathematics

On the Functional Representation of Certain Algebraic Systems. J. H. Williamson. *Pacific J. Math.*, Summer 1957, pp. 1,251–1,277. Generalization of the well-known representation theory of commutative Banach algebras by functions on the maximal ideals of the algebra.

Dimension and Non-Density Preservation of Mappings. G. T. Whyburn. *Pacific J. Math.*, Summer 1957, pp. 1,243–1,249. Consideration of conditions under which the property of being nondense in a space, in the sense of containing no open set in that space, is invariant under certain types of mapping.

Ob Ustoichivosti Sistem s Malym Mnozhitelem. B. S. Razumikhin. *Prikl. Mat. i Mekh.*, 1957, pp. 578–580. In Russian. Evaluation of the stability of a system of linear differential equations.

Issledovanie Zadachi ob Ustoichivosti dlia Sistem Uravnenii s Odnorodnymi Pravymi Chastiami. V. I. Zubov. *AN SSSR Dokl.*, June 11, 1957, pp. 942–944. In Russian. Investigation of the stability problem for systems of equations with homogeneous right-hand members.

Rasprostranenie Nekotorykh Rezul'tatov na Lineinye Kanonicheskie Sistemy s Periodicheskimi Koeffitsientami. V. A. Iakubovich. *Prikl. Mat. i Mekh.*, 1957, pp. 491–502. In Russian. Extension of Liapunov's results to linear canonic systems with periodic coefficients.

O Zadache Lame dlia Parallelepipeda v Obshchem Sluchae Poverkhnostnykh Nagruzok. M. M. Filonenko-Borovich. *Prikl. Mat. i Mekh.*, 1957, pp. 550–559. In Russian. Application of Kastilliano's variational method to the problem of the state of stress of an elastic parallelepiped loaded at the edges. Two tensors are analyzed—

XUM

Flight-Proven Fire Detection:

Consider these three important facts!

1 Kidde's Continuous Strip Fire Detector, first of its kind on the market, has been *proven* successful by more than seven years of intensive *flight* experience on both military and commercial aircraft.

2 As a result, the majority of U. S. commercial transport manufacturers and air lines already using continuous strip fire detection have chosen the Kidde system.

3 Kidde's sensing element and adjustable control unit affords a wide range of settings through the greatest operating temperature range . . . a Kidde exclusive which makes the Kidde system not only ideal for present-day aircraft but especially effective for aircraft now in the developmental stage.

Let Kidde's unrivalled experience in the field of aircraft fire detection help solve *your* safety problems. Write today for facts on the advantages of the Kidde system . . . *the* continuous strip fire detector *proven in flight!*

Kidde

Walter Kidde & Company, Inc.
Aviation Division
211 Main Street, Belleville 9, N. J.

District Sales Engineering Offices:
Dallas, Tex.—Dayton, Ohio—St. Louis, Mo.
Seattle, Wash.—Van Nuys, Calif.—Washington, D. C.

Walter Kidde-Pacific, Van Nuys, California
Walter Kidde & Company of Canada Ltd., Montreal

the basic tensor, satisfying the given boundary conditions and differential stability equations, and the correcting tensor, satisfying the zero boundary conditions, the differential stability equations, and having linearly a sufficient number of random varying parameters.

O Kanonicheskikh Preobrazovaniiakh Uravnenii Teorii Avtomaticheskogo Regulirovaniia pri Nalichii Kratnykh Kornei. V. A. Troitskii. *Prikl. Mat. i Mekh.*, 1957, pp. 574–577. In Russian. Canonical transformations of equations in the theory of automatic control in the case of multiple roots.

Mathematical Results Related to a Problem in Wave Propagation. Meir Hanin. *J. Math. & Phys.*, Oct., 1957, pp. 250–260. Method for the evaluation of a Neumann series N_ν, μ, and the determination of a class of functions satisfying ordinary third-order differential equations.

Formuly dlia Vychisleniia Opredelitelia Kvadratnoi Matritsy Odnogo Chastnogo Vida. V. Ia. Natanzon. *Prikl. Mat. i Mekh.*, 1957. pp. 593–595. In Russian. Derivation of formulas for the calculation of the determinant of a square matrix.

Ob Odnom Klasse Nepreryvnykh Otobrazhenii Nekotorykh Beskonechnomernykh Mnozhestv. S. S. Ryshkov. *AN SSSR Dokl.*, June 11, 1957, pp. 961–963. In Russian. Study of a class of continuous mappings of some ∞-dimensional sets.

Vyrozhdenie pri Perekhode ot Diskretnogo Spektra k Nepreryvnomu i Perekhod iz Kvantovoi Mekhaniki v Klassicheskuiu. V. P. Maslov. *AN SSSR Dokl.*, June 11, 1957, pp. 957–960. In Russian. Degeneration on passing from a discrete spectrum to a continuous one and transition from quantum mechanics to classical mechanics.

O Predstavlenii Nepreryvnykh Funktsii Neskol'kikh Peremennykh v Vide Superpozitsii Nepreryvnykh Funktsii Odnogo Peremennogo i Slozheniia. A. N. Kolmogorov. *AN SSSR Dokl.*, June 11, 1957, pp. 953–956. In Russian. Representation of continuous functions of many variables by superposition of continuous functions of one variable and addition.

Ob Asimptoticheskom Povedenii Reshenii Lineinykh Raznostnykh i Differentsial'nykh Uravnenii. P. I. Koval'. *AN SSSR Dokl.*, June 11, 1957, pp. 949–952. In Russian. Discussion of the asymptotic behavior of solutions of linear difference equations and linear differential equations.

O Primenenii Metoda Momentov i "Smeshannogo" Metoda k Priblizhennomu Resheniiu Singuliarnykh Integral'nykh Uravnenii. V. V. Ivanov. *AN SSSR Dokl.*, June 11, 1957, pp. 945–948. In Russian. Discussion of the application of the method of moments and the "mixed" method to obtain the approximate solution of singular integral equations.

Teoremy Vlozheniia dlia Prostranstva s Metrikoi, Vyrozhdaiushcheisia v Konechnom Chisle Vnutrennikh Tochek Ogranichennoi Oblasti. V. K. Zakharov. *AN SSSR Dokl.*, June 11, 1957, pp. 938–941. In Russian. Derivation of imbedding theorems for a space having its metric degenerating at a finite number of internal points within a bounded domain.

Reshenie Metodom Fur'e Nesamosopriazhennykh Smeshannykh Zadach dlia Giperbolicheskikh Sistem na Ploskosti. V. F. Zhdanovich. *AN SSSR Dokl.*, June 11, 1957, pp. 934–937. In Russian. Application of the Fourier method to the solution of non-self-adjoint mixed problems for hyperbolic systems on a plane.

O Priblizhenii Nekotorykh Klassov Nepreryvnykh Funktsii Summami Fur'e i Summami Feiera. A. V. Efimov. *AN SSSR Dokl.*, June 11, 1957, pp. 930–933. 17 refs. In Russian. Derivation of an approximation of certain classes of continuous functions by Fourier and Fejer sums.

O Ravnomerno-Nailuchshem Priblizhenii Polinomov. E. V. Voronovskaia. *AN SSSR Dokl.*, June 11, 1957, pp. 927–929. In Russian. Analysis of the closest form approximation of polynomials.

Nekotorye Otsenki iz Teorii Tabulirovaniia. A. G. Vitushkin. *AN SSSR Dokl.*, June 11, 1957, pp. 923–926. In Russian. Presentation of some estimates from the tabulation theory.

K Voprosu ob Otsenkakh Priblizhennykh Integrirovanii. N. G. Chetaev. *Prikl. Mat. i Mekh.*, May-June, 1957, pp. 419–423. In Russian. Discussion of the problem of evaluating approximate integrations.

A Three Point Convexity Property. F. A. Valentine. *Pacific J. Math.*, Summer 1957, pp. 1,227–1,235. Study of clearly defined closed sets in the n-dimensional Euclidean space E_n.

Ob Odnom Analoge Teorii Rasshirenii Ermitovykh Operatorov i Nesimmetricheskoi Odnomernoi Kraevoi Zadache na Poluosi. I. M. Glazman. *AN SSSR Dokl.*, July 11, 1957, pp. 214–216. In Russian. An analogue of the extension theory of Hermitian operators and a nonsymmetric one-dimensional boundary problem on a half-axis.

Odnoznachnaia Opredelennost' Nekotorykh Vypuklykh Poverkhnostei v Prostranstve Lobachevskogo. I. A. Danelich. *AN SSSR Dokl.*, July 11, 1957, pp. 217–219. In Russian. Discussion of the unequivocal definiteness of certain convex surfaces in the Lobachevski space.

Physical Properties of Some Empty Space-Times. V. Joseph. *Cambridge Philos. Soc. Proc.*, Oct., 1957, pp. 836–847. Calculation of the canonical form of the Riemann tensor for certain nonflat empty space-times, and investigation of some invariant physical properties of these space-times.

Orthogonal and Oblique Projectors and the Characteristics of Pairs of Vector Spaces. S. N. Afriat. *Cambridge Philos. Soc. Proc.*, Oct., 1957, pp. 800–816. Development of an algebraic theory which supplies terms necessary for a unified algebraic and geometric formulation of concepts in multivariate analysis.

O Sostavlenii Uravnenii v Konechnykh Raznostiakh pri Priblizhennom Reshenii Uravneniia Laplasa. N. S. Bakhvalov. *AN SSSR Dokl.*, June 21, 1957, pp. 1,146–1,148. In Russian. Construction of difference equations for an approximate solution of Laplace equation.

Vychislenie Sobstvennykh Znachenii Polinomnoi Matritsi. V. Ia. Natanzon. *Prikl. Mat. i Mekh.*, May–June, 1957, pp. 445–448. In Russian. Calculation of eigenvalues of polynomial matrices.

O Kharakteristicheskoi Funktsii $A(\lambda)$ Lineinoi Kanonicheskoi Sistemy Differentsial'nykh Uravnenii Vtorogo Poriadka s Periodicheskimi Koefitsientami. M. G. Krein. *Prikl. Mat. i Mekh.*, May–June, 1957, pp. 320–329. In Russian. Derivation of the characteristic function $A(\lambda)$ of the linear canonical system of second-order differential equations with periodic coefficients.

Ob Ustoichivosti pri Bol'shikh Nachal'nykh Vozmushcheniiakh. N. N. Krasovkii. *Prikl.*

Passes Tests With Flying Colors

MILITARY AIRCRAFT MOTOR

. . . equal dependability for your product

One of the recent Lamb Electric developments is a motor to drive submerged pumps on military aircraft—for transfer of fuel from reserve to engine tanks.

For such an important application, motor reliability far beyond that normally called for was needed. To insure this degree of reliability in its actual operation of driving the submerged pump, test requirements for the motor were exceptionally rigorous.

As the result of advanced engineering and design, greatly increased brush life, and ability to operate at extremely high temperatures and withstand severe shock tests, the motor passed gruelling tests with flying colors.

The skill and experience exemplified here is available to your company to provide dependable power for *your* new or redesigned products.

THE LAMB ELECTRIC COMPANY • KENT, OHIO

A Division of American Machine and Metals, Inc.

In Canada: Lamb Electric—Division of Sangamo Company Ltd.—Leaside, Ontario

Lamb Electric

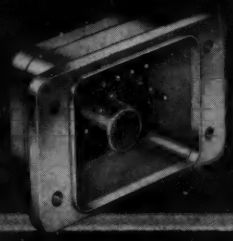
SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

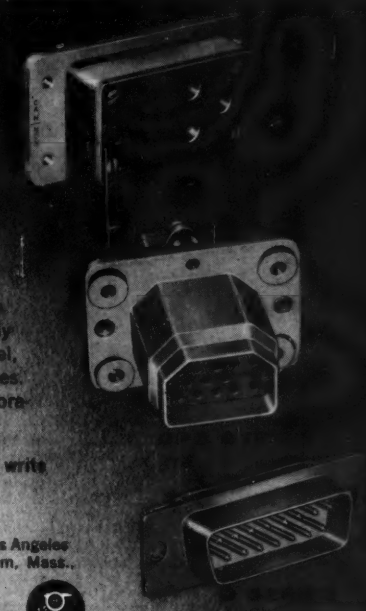
RELIABLE

Rack-Panel-Chassis Connectors

for RAPID DISCONNECT

Faster Inspection... Faster Testing...
Faster Servicing... Maximum Interchangeability





Cannon offers you more than 18 different basic designs in rack-panel-chassis connectors... designed with all the latest features to give accurate alignment, easy mating, proper connection, and moisture sealing where desired.

Select the connector you want in standard, miniature, or sub-miniature sizes... for standard circuitry or printed circuitry. Up to 156 contacts... and a great number of combinations of contacts for control, audio, thermocouple, co-ax, twin-ax, and pneumatic connections. In single- or double-gang. Some with shells, some without... all ruggedly constructed to take the many "in" and "out" operations of rack, panel, chassis, and sub-assembly applications. Special moisture-proof types. Standby units featuring gold-plated contacts to withstand deterioration and corrosion.

For an interesting discussion of the broad subject of "Reliability," write for Cannon Bulletin R-1.

CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles 31, California. Factories in Los Angeles, Salem, Mass., Toronto, Can., London, Eng., Melbourne, Austl. Manufacturing licensees in Paris and Tokyo. Representatives and distributors in all principal cities. **Please refer to Dept. 105.**

For reliability in your rack-panel-chassis connectors... connect with Cannon! Write for Bulletin DP-10 and DP-101 Supplement.

CANNON PLUGS

WHERE RELIABILITY IS THE 5TH DIMENSION

Mat. i Mekh., May-June, 1957, pp. 309–319. 19 refs. In Russian. Study of the problem of stability in the case of large initial disturbances.

Obobshchennye Resheniia Uravnenii Monzha-Ampera. I. Ia. Bakel'man. *AN SSSR Dokl.*, June 21, 1957, pp. 1,143–1,145. In Russian. Generalization of the solution of Monge-Ampere equations.

O Resheniiakh Nelineinykh Differentsial'nykh Uravnenii Vtorogo Poriadka s Medlenno Izmeniaiushchimisia Koeffitsientami. V. M. Volosov. *AN SSSR Dokl.*, June 21, 1957, pp. 1,149–1,152. In Russian. Derivation of solutions of second-order nonlinear differential equations with slowly varying coefficients.

Ob Odnom Klasse Obratimykh Operatorov v Kol'tse Analiticheskikh Funktsii. M. A. Evgrafov and A. D. Solov'ev. *AN SSSR Dokl.*, June 21, 1957, pp. 1,153, 1,154. In Russian. Discussion of a class of irreversible operators in a ring of analytical functions.

O Klassakh Korrektnosti dlia Nekotorykh Granichnykh Zadach. S. G. Krein. *AN SSSR Dokl.*, June 21, 1957, pp. 1,162–1,165. In Russian. Analysis of the correctness classes for certain boundary problems.

O Poriadke Priblizheniia Funktsii Lineinymi Polozhitel'nymi Operatorami. P. P. Korovkin. *AN SSSR Dokl.*, June 21, 1957, pp. 1,158–1,161. In Russian. Discussion of the order of the approximation of functions by linear positive operators.

Asimptoticheskie Predstavleniia Sferoidal'nykh Funktsii s Azimutal'nym Indeksom $m = 1$. M. G. Belkina. *AN SSSR Dokl.*, June 21, 1957, pp. 1,185–1,188. In Russian. Asymptotic representations of spheroid functions with an azimuth index $m = 1$.

O Gruppakh s Konechnymi Klassami Sopriazhennykh Elementov. S. N. Chernikov. *AN SSSR Dokl.*, June 21, 1957, pp. 1,177–1,179. In Russian. Analysis of groups with finite classes of conjugated elements.

Rasshireniia Prostranstv Abstraktnykh Funktsii, Sviazannye s Teoriei Integrala. S. L. Sobolev. *AN SSSR Dokl.*, June 21, 1957, pp. 1,170–1,173. In Russian. Extension of abstract function spaces connected with the integral theory.

Pervaia Kraevaia Zadacha dlia Kvazilineinykh Ellipticheskikh Uravnenii. S. S. Dymkov. *AN SSSR Dokl.*, July 11, 1957, pp. 220–222. In Russian. Study of the first boundary problem for quasilinear elliptical equations.

O Skhodimosti Odnogo Vidoizmeneniia Metoda Galerkina. G. A. Zhdanov. *AN SSSR Dokl.*, July 11, 1957, pp. 223–225. In Russian. Discussion of the convergence of a modification of the Galerkin method.

Ob Odnom Normirovannom Kol'tse Funktsii so Svertyvaniem. B. I. Korenblium. *AN SSSR Dokl.*, July 11, 1957, pp. 226–229. In Russian. Study of a normalized ring of functions with convolution.

O Kraevykh Zadachakh na Sobstvennye Znacheniia i Sobstvennye Funktsii dlia Obyknovennykh Differentsial'nykh Uravnenii, Soderzhashchikh Malyi Parametr pri Starshei Proizvodnoi. D. P. Kostomarov. *AN SSSR Dokl.*, July 11, 1957, pp. 230–233. In Russian. Discussion of boundary problems of eigenvalues and characteristic functions of ordinary differential equations containing a small parameter in the highest derivative term.

O Polnote Sistemy Sobstvennykh i Prisoedinennykh Elementov Vpolne Nepreryvnogo Operatora. V. B. Lidskii. *AN SSSR Dokl.*, July 11, 1957, pp. 234–236. In Russian. Analysis of the completeness of a system of eigenelements and adjoint elements of a compact operator.

O Nekotorykh Predel'nykh Teoremakh dlia Odnorodnykh Tsepei Markova. S. V. Nagaev. *AN SSSR Dokl.*, July 11, 1957, pp. 237–239. In Russian. Discussion of some limit theorems for homogeneous Markoff chains.

O Priblizhennykh Metodakh Resheniia Differentsial'nykh Uravnenii v Banakhovom Prostranstve. P. E. Sobolevskii. *AN SSSR Dokl.*, July 11, 1957, pp. 240–243. In Russian. Development of approximate methods for the solution of differential equations in Banach space

Nekotorye Teoremy ob Ustoichivosti Resheniĭ Parabolicheskikh Sistem. S. D. Eidel'man. *AN SSSR Dokl.*, July 11, 1957, pp. 253–255. In Russian. Development of theorems on the stability of the solutions of parabolic systems.

Polynomials of Best Approximation on a Real Finite Point Set. I. T. S. Motzkin and J. L. Walsh. *Harvard U., Rep.* (*OSR TN 57–406*) [*AD 132484*], Sept. 1957. 23 pp. Systematic study of the various properties which polynomials of given degree of best approximation have in common, especially those relating to oscillation of the difference.

O Polnote Sistemy Sobstvennykh i Prisoedinennykh Elementov Nesamosopriazhennykh Operatorov, Blizkikh k Normal'nym. Dzh. E. Allakhverdiev. *AN SSSR Dokl.*, July 11, 1957, pp. 207–210. In Russian. Analysis of the completeness of a system of eigenelements and adjoined elements of nonselfadjoined operators close to normal ones.

O Koeffitsientakh Tipichno-Veshchestvennykh Funktsii. S. A. Gel'fer. *AN SSSR Dokl.*, July 11, 1957, pp. 211–213. In Russian. Study of coefficients of typically real functions.

Geometrical Characterizations of Biorthogonal Basis Systems in a Banach Space. R. E. Fullerton. *U. Md. Dept. Math. Rep.* (*AFOSR TN 57–426*) [*AD 136415*], July 1957. 17 pp. Theoretical extension of previous work to show that the presence of a biorthogonal basis cone in a Banach space is necessary in order for a biorthogonal basis system to exist.

Uniform Convergence for Monotone Mappings. Gordon T. Whyburn. *Va. U., Dept. Math. TN 3* (*AFOSR TN 57–589*), Sept., 1957. 12 pp. Outline of some recent results and methods leading to existence conclusions for uniform convergence of sequences of mappings in a topological setting, and to indicate their relation and applicability to sequences of real functions in particular.

Curve Fitting. T. R. Hoffmann. *Allis-Chalmers Elec. Rev.*, 3rd Quarter, 1957, pp. 14–17. Presentation of methods by which familiar equations and easy calculations enhance the usefulness of empirical data and facilitate accurate graphic presentations.

The Fredholm Eigen Values of Plane Domains M. Schiffer. *Pacific J. Math.*, Summer 1957, pp. 1,187–1,225. 14 refs. ONR-supported study of the eigenfunctions and eigenvalues of the homogeneous Fredholm equation, which is connected with the boundary value problem of two-dimensional potential theory.

Three Test Problems in Operator Theory. Richard V. Kadison and I. M. Singer. *Pacific J. Math.*, Summer 1957, pp. 1,101–1,106. ONR-supported application of three problems of Kaplansky to the testing of a unitary equivalence theory for operators on a Hilbert space.

Lie Algebras of Locally Compact Groups. Richard K. Lashof. *Pacific J. Math.*, Summer 1957, pp. 1,145–1,162. Theoretical investigation of the projective limit of Lie algebras, the Lie algebra of an LP-group, the universal covering group, and subgroups and subalgebras.

On Spaces with a Multiplication. I. M. James. *Pacific J. Math.*, Summer 1957, pp. 1,083–1,100. Discussion of the homotopy theory of mappings into a space with a multiplication, and application of the theory to specific reduced product spaces and loop-spaces.

Asymptotic Behavior of Restricted Extremal Polynomials and of Their Zeros. M. Fekete and J. L. Walsh. *Pacific J. Math.*, Summer 1957, pp. 1,037–1,064. 12 refs. ONR-supported combination of two recent trends in the study of polynomials by studying the asymptotic properties of sequences of polynomials for the least norm on a given set, where the polynomials are restricted by prescription of one or more coefficients.

The Lattice of Invariant Subspaces of a Completely Continuous Quasi-Nilpotent Transformation. W. F. Donoghue, Jr. *Pacific J. Math.*, Summer 1957, pp. 1,031–1,035. ONR-supported theoretical investigation to show that the structurally simple lattice of invariant subspaces is the maximum which can be obtained, and that this very simple lattice does in fact occur.

Ob Ogranichennykh Resheniiakh Zadannogo na Polubeskonechnom Intervale Neodnorodnogo Integral'nogo Uravneniia s Iadrom, Zavisiashchim ot Raznosti Argumentov. T. A. Germogenova. *AN SSSR Dokl.*, July 1, 1957, pp. 23–26. In Russian. Derivation of bounded solutions of an inhomogeneous integral equation given on a semi-infinite interval and having its kernel dependent on the difference of the arguments.

O Periodicheskikh Resheniiakh Nelineinogo Uravneniia Avtokolebanii. V. M. Volosov. *AN SSSR Dokl.*, July 1, 1957, pp. 20–22. In Russian. Derivation of the solution of a nonlinear equation of auto-oscillation.

O Skhodimosti Posledovatel'nostei Lineinykh Polozhitel'nykh Operatorov v Prostranstve Nepreryvnykh Funktsii Dvukh Peremennykh. V. I. Volkov. *AN SSSR Dokl.*, July 1, 1957, pp. 17–19. In Russian. Analysis of the convergence of sequences of linear positive operators in the space of continuous functions of two variables.

Privedenie Lineinoi Sistemy Uravnenii v Chastnykh Proizvodnykh s Postoiannymi Koeffitsientami k Sisteme Normal'nogo Tipa. V. M. Borok. *AN SSSR Dokl.*, July 1, 1957, pp. 13–16. In Russian. Reduction of a system of linear partial differential equations with constant coefficients to the normal form.

O Zadache Koshi dlia Odnogo Klassa Nelineinykh Uravnenii v Funktsional'nykh Prostranstvakh. K. T. Akhmedov. *AN SSSR Dokl.*, July 1, 1957, pp. 9–12. In Russian. Study of the Cauchy problem for a class of nonlinear equations in functional spaces.

On the Eigenvalue Latzko's Differential Equation. H. E. Fettis. *ZAMM*, Sept.-Oct., 1957, pp. 398, 399.

Zur Abschätzung des Restgliedes der Mittelwertformeln zur genäherten Quadratur. H. Schlechtweg. *ZAMM*, Sept.-Oct., 1957, pp. 353–361. In German. The points of division, x_ν, in the formula for quadrature are used in conjunction with the zeros of the periodic Bernoulli polynomials $\bar{B}_1(x_\nu - x)$ and $\bar{B}_1(x_\nu - x + 1)$ in order to obtain an estimate for the remainder given by the First derivative of the function to be integrated.

O Spektral'nykh Funktsiiakh Differentsial'nogo Operatora Chetnogo Poriadka. A. V. Shtraus. *AN SSSR Dokl.*, July 1, 1957, pp. 67–70. In Russian. Evaluation of spectral functions of an even order differential operator.

O Edinstvennosti v Obratnoi Zadache Teorii Potentsiala. Iu. A. Shashkin. *AN SSSR Dokl.*, July 1, 1957, pp. 64–66. In Russian. Discussion of the uniqueness in the inverse problem of the potential theory.

O Stroenii Grupp s Konechnymi Klassami Sopriazhennykh Elementov. S. N. Chernikov. *AN SSSR Dokl.*, July 1, 1957, pp. 60–63. In Russian. Analysis of the structure of groups with finite classes of conjugate elements.

Teoremy Vlozheniia dlia Abstraktnykh Funktsii Mnozhestv. S. L. Sobolev. *AN SSSR Dokl.*, July 1, 1957, pp. 57–59. In Russian. Development of imbedding theorems for abstract functions of sets.

Lokal'nye Predel'nye Teoremy dlia Bol'shikh Uklonenii. Vol'fgang Rikhter. *AN SSSR Dokl.*, July 1, 1957, pp. 53–56. In Russian. Development of local limit theorems for large deviations.

Lokal'naia Teorema dlia Reshetchatykh Raspredelenii. V. V. Petrov. *AN SSSR Dokl.*, July 1, 1957, pp. 49–52. 10 refs. In Russian. Development of a local theorem for latticed distributions.

O Vychisleniĭ Sobstvennykh Znachenii Integral'nogo Uravneniia pri Pomoshchi Sledov Portornykh Iader. I. P. Mysovskikh. *AN SSSR Dokl.*, July 1, 1957, pp. 45–48. In Russian. Calculation of the eigenvalues of integral equations by means of iterated kernels.

Ergodic Properties of Some Simple Stochastic Processes. Alladi Ramakrishnan. *ZAMM*, Sept.-Oct., 1957, pp. 336–344.

Abschätzung der Lösung der ersten Platten-Randwertaufgabe nach der Methode von Maple-Synge. Rüdiger Nicolovius. *ZAMM*, Sept.-Oct., 1957, pp. 344–349. In German. Application of the Synge hypercircle method to obtain an estimate for the solution of the first biharmonic boundary value problem which corresponds to Maple's estimate for the solution of the first boundary value problem of the potential theory.

Pervaia Kraevaia Zadacha dlia Nelineinogo Ellipticheskogo Uravneniia Vtorogo Poriadka v Ogranichennoi Oblasti s Vyrozhdennoi Granitsei. A. L. Krylov. *AN SSSR Dokl.*, July 1, 1957, pp. 42–44. In Russian. Study of the first boundary problem for a nonlinear second-order elliptic equation in a bounded domain with a degenerate boundary.

O Nekotorykh Svoistvakh Riadov po Polynomam Fabera. T. I. Krasnoshchekova. *AN SSSR Dokl.*, July 1, 1957, pp. 38–41. In Russian. Discussion of certain properties of series in Faber polynomials.

O Spektral'nykh Svoistvakh Samosopriazhennykh Ellipticheskikh Operatorov. A. G. Kostiuchenko. *AN SSSR Dokl.*, July 1, 1957, pp. 34–37. In Russian. Analysis of the spectral properties of elliptical operators.

Ob Otyskanii Klassa Skhodimosti Nekotorykh Interpoliatsionnykh Zadach. M. A. Evgrafov. *AN SSSR Dokl.*, July 1, 1957, pp. 31–33. In Russian. Determination of the class of convergence in certain interpolation problems.

O Sushchestvovanii Reshenii Zadachi Koshi dlia Nekotorogo Klassa Uravnenii s Chastnymi Proizvodnymi. G. M. Gusachenko. *AN SSSR Dokl.*, July 1, 1957, pp. 27–30. In Russian. Discussion of the existence of solutions to Cauchy problem for a certain class of partial differential equations.

Mechanics

K Ustoichivosti Permanentnykh Vrashcheniĭ Tverdogo Tela Okolo Nepodvizhnoi Tochki. V. V. Rumiantsev. *Prikl. Mat. i Mekh.*, May-June, 1957, pp. 339–346. In Russian. Evaluation of the stability of a solid body continuously rotating about a fixed point.

Meteorology

Der durch eine vertikale Verdünnungswelle in der Atmosphäre erzeugte Verdichtungsstoss. Wolfgang Franke. *ZFW*, Oct., 1957, pp. 292–302. In German. Calculation of the wave of rarefaction due to a given downwash in a one-dimensional adiabatic atmosphere by means of the known method of characteristics.

Electric Field Measurements Above Thunderstorms. C. G. Stergis, G. C. Rein, and T. Kan-

XUM

gas. *J. Atmos. & Terrestrial Phys.*, No. 2, 1957, pp. 83–90. Measurements made in the central Florida area by a series of twenty-five balloon flights made at altitudes from 70,000 to 90,000 ft. above sea level. Tests indicate that there is a positive current of approximately 1.3 A on the average, flowing from the top of the storm to the ionosphere.

Electric Field Measurements in the Stratosphere. C. G. Stergis, G. C. Rein, and T. Kangas. *J. Atmos. & Terrestrial Phys.*, No. 2, 1957, pp. 77–82. Measurements up to altitudes of 90,000 ft. using balloons. The tests indicate that the electric field in the atmosphere, above the exchange layer, decreases monotonically with height up to the maximum height at which measurements are made.

Sulla Ricerca del Procedimento più Opportuno per l'Applicazione del Metodo di Analisi Grafica. G. Fea, M. Montalto, and A. Gazzola. *Riv. Meteorologia Aero.*, Oct.-Dec., 1957, pp. 3–13. In Italian. Results of research carried out to determine the spacing between isotachs and the shift along positive axis directions for practical applications of objective graphic analysis, on a synoptic scale, of tropospheric velocity fields.

Military Aviation & Armament

Evolution or Revolution. *Air BP*, No. 4, 1957, pp. 14–18. Discussion of the problem of converting from piloted fighter aircraft to guided missiles.

"Fledermaus", ein radargesteuertes, vollautomatisches Feuerleitgerät. A. F. Braun. *Flugwehr & -Technik*, Oct., 1957, pp. 268–271. In German. General and structural aspects of the "Fledermaus," a radar controlled, completely automatic fire-direction device.

Beitrag zur Diskussion über die modernen Waffen der leichten und mittleren Fliegerabwehr. Hans Baasch. *Flugwehr & -Technik*, Oct., 1957, pp. 266–268. In German. Discussion of modern arms for light and mean air defense.

The Theory of Search. III—The Optimum Distribution of Searching Effort. Bernard O. Koopman. *Oper. Res.*, Oct., 1957, pp. 613–626. Consideration of a class of problems in which the expression to be optimized is nonlinear and in which only two linear side-conditions are given.

Lighter, Slower, Cheaper. Pierre M. Gallois. *Interavia*, Sept., 1957, pp. 893–895. Discussion of the technical, economic, and operational considerations behind NATO's program for a light strike fighter.

A Tactical Air Game. D. R. Fulkerson and S. M. Johnson. *Oper. Res.*, Oct., 1957, pp. 704–712. Formulation of a discrete, linear model of a tactical air war as a multi-move game. The symmetric case in which the attrition rates are the same for both sides is solved for both finite and infinite campaigns.

Missiles

On Optimum Nose Shapes for Missiles in the Superaerodynamic Region. I. D. Chang. *J. Aero. Sci.*, Jan., 1958, pp. 57, 58. Solution for the equations of optimum nose shape derived by W. J. Carter.

"Flying" Missiles on the Ground. Eric Burgess. *Astronautics*, Nov., 1957, pp. 46, 47, 80. Description of a flight simulation table coupled with an analog computer that provides means for checking out components prior to actual flight testing.

Special Issue: Missile Systems Engineering. *Av. Age*, Nov., 1957. 64 pp. *Partial Contents*: Missile Business Offers New Opportunities for Aviation Industry, Victor DeBiasi. Six Years Development Work Went Into Sparrow I, Victor DeBiasi. Hypersonic Missiles Change Aerodynamic Theory, William H. Dorrance. Choosing Rocket Engines for Large Missiles, K. J. Brossart. Transient Heat Flow Studies Aid Design of Reinforced Plastic Structures, J. L. Dietz and W. J. Hangen. Designing Flight Control Systems for Ballistic Missiles Mission Profile Determines Functional Organization of Controls, Joseph A. Miller. Helium Makes Regulator Problems More Critical, W. O. Borcherdt. Helium: General Properties and Compressibility, Jesse T. Simmons. Missile Target Drones: R & D Testing. Guidance. Three Approaches to Inertial System Design, James Holahan. Ground Support. Operational Test Equipment Must be Tailored to Missile and its Crew, George A. Harter. Armament.

The West's Guided Missiles. *Interavia*, Aug., 1957, pp. 795–798. Presentation of data in tabular form for NATO countries, Switzerland, and Japan.

Photoelectric Target for Missile Tests. Samuel E. Dorsey. *Electronics*, Nov. 1, 1957, pp. 141–143. Application of banks of phototubes, arranged to have crossing trajectories, in order to determine rectangular coordinates of a missile being tested.

On Optimum Nose Curves for Missiles in the Superaerodynamic Regime. H. S. Tan. *J. Aero. Sci.*, Jan., 1958, pp. 56, 57. Solution for the equation of optimum nose shape derived previously by W. J. Carter.

Die britischen Lenkwaffen. *Flugwelt*, Oct., 1957, pp. 717–724. In German. Review of the British guided weapons presented at Farnborough in 1957, such as Armstrong Whitworth Seaslug,

An Invitation To Join ORO . . . Pioneer In Operations Research

Operations Research is a young science, earning recognition rapidly as a significant aid to decision-making. It employs the services of mathematicians, physicists, economists, engineers, political scientists, psychologists, and others working on teams to synthesize all phases of a problem.

At ORO, a civilian and non-governmental organization, you will become one of a team assigned to vital military problems in the area of tactics, strategy, logistics, weapons systems analysis and communications.

No other Operations Research organization has the broad experience of ORO. Founded in 1948 by Dr. Ellis A. Johnson, pioneer of U. S. Opsearch, ORO's research findings have influenced decision-making on the highest military levels.

ORO's professional atmosphere encourages those with initiative and imagination to broaden their scientific capabilities. For example, staff members are taught to "program" their own material for the Univac computer so that they can use its services at any time they so desire.

ORO starting salaries are competitive with those of industry and other private research organizations. Promotions are based solely on merit. The "fringe" benefits offered are ahead of those given by many companies.

The cultural and historical features which attract visitors to Washington, D. C. are but a short drive from the pleasant Chevy Chase suburb in which ORO is located. Attractive homes and apartments are within walking distance and readily available in all price ranges. Schools are excellent.

For further information write:
Professional Appointments

OPERATIONS RESEARCH OFFICE
ORO The Johns Hopkins University
7100 CONNECTICUT AVENUE
CHEVY CHASE 15, MARYLAND

Bristol Bloodhound, de Havilland Firestreak, and English Electric Thunderbird.

Automatic Test Equipment for Weapon Systems. David Y. Keim. *Missile Des. & Devel.*, Nov., 1957, pp. 16, 17. Discussion of the Sperry system, methods of fault isolation, parallel primary tests, comparator selection, the function of the indicator panel, and the development of a system design for RACE.

Chemistry, Rockets and the Future. Dan A. Kimball. *Comm. Chem. Devel. Assoc. Conf., French Lick, Ind., May 13, 1957.* 13 pp. Survey of the rocket industry, including special mention of the chemical aspects and of its two current major projects, ICBM and Vanguard.

Evaluating Relays for Guided Missiles. D. D. Zimmerman. *Mil. Electronics*, Oct., 1957, pp. 40–42. Development of a procedure intended as a universal method of analyzing characteristics of electromagnetic units for weapon purposes. Suggested steps include (1) study of engineering data to classify relay type, (2) inspection and testing of mechanical and electrical characteristics, (3) environmental testing of relay to determine operational and survival limitations, and (4) determination of operating and nonoperating life characteristics.

America's Surface-to-Surface Missile Arsenal. Frederick I. Ordway and Ronald C. Wakeford. *Spaceflight*, Oct., 1957, pp. 176–184. Survey of U. S. achievements in guided missile research and design.

Ballistic Missile Telemetry. Lawrence L. Rauch. *IRE Trans., TRC Ser.*, May, 1957, pp. 2–5. Discussion emphasizing some of the significant requirements for telemetry posed by ballistic missile development programs as compared to the previous and current use of telemetry.

Aided Inertial Navigation Systems. Frederick Stevens and Frank W. Lynch. *Western Av.*, Nov., 1957, pp. 6–9. Discussion of self-contained navigational systems which are capable of accurately determining the position of a moving vehicle without reference to any landmarks, to any magnetic fields, or to any radiation fields.

Navigation

Auto-Plotting Navigation in the Jet Era. Howard B. Capes. *Aeronautics*, Nov., 1957, pp. 36–39. Description of the operation of the Decca Navigator System, the only existing area coverage aid providing pictorial presentation to the pilot. Future possibilities for Decca systems are discussed.

Inertial Navigation; Position Finding by Accelerometers, Gyroscopes and Pendulum. Norman F. Parker and Charles P. Greening. *Interavia*, June, 1957, pp. 575–577. Discussion of principles of inertial navigation; includes system error correction and component requirements.

Global Navigation in High Speed Aircraft. Keith R. Greenaway. *CAI-IAS Joint Meeting, Montreal, Oct. 21, 22, 1957, Preprint 753.* 7 pp. Members, $0.35; nonmembers, $0.75. Discussion of the self-contained aids which will be necessary in order for high speed aircraft flying global routes to navigate efficiently until a common aid is available. Doppler radar will be the primary aid and its introduction will be a major advancement in air transport navigation.

Electronic Aids

C-W Radar and the Mid-Air Collision Problem. J. Q. Brantley, Jr. *Mil. Electronics*, Oct., 1957, pp. 28–30, 33. Presentation of a theoretically ideal radar collision-warning device capable of surveying the surrounding air space to detect any object entering this space, announcing its presence to the pilot, and indicating the object's range and relative bearing.

Tacan Combines Accurate Navigation with Strict Airspace Control. *Interavia*, June, 1957, pp. 553–556. Discussion of the advantages of TACAN, and a description of ground and air operation.

Nuclear Energy

Nuclear Shielding Materials for Electronic Circuits. John R. Hendrickson. *Elec. Mfg.*, Nov., 1957, pp. 130–134. Discussion of various shielding materials suitable for incorporation into the design of electronic devices and equipment for nuclear-powered aircraft, or for operation where exposure to nuclear radiation may be expected.

Photography

Recent Developments in Aerial Survey. Roy Hall. *Hunting Group Rev.*, Autumn, 1957, pp. 4–8.

Physics

Issledovanie Sostava Pervichnogo Kosmicheskogo Izlucheniia. S. N. Vernov, V. L. Ginzburg, L. V. Kurnosova, L. A. Razorenov, and M. I. Fradkin. *Uspekhi Fiz. Nauk*, No. Ia, Ib, Sept., 1957, pp. 131–144, 145–148. 48 refs. In Russian. Investigation of cosmic radiation and discussion of the possibility of obtaining more detailed data from satellite instruments.

O Dvizhenii Sosuda, Chastichno Zapolnennogo Zhidkost'iu; Uchet Nemalosti Dvizheniia Poslednei. G. S. Narimanov. *Prikl. Mat. i Mekh.*, 1957, pp. 513–524. In Russian. Study of the motion of a solid body partly filled with liquid, taking into account the importance of the motion of the liquid.

Self-Distortion of Radio Waves in the Ionosphere, Near the Gyro Frequency. F. H. Hibberd. *J. Atmos. & Terrestrial Phys.*, No. 2, 1957, pp. 102–110. Extension of previous analysis on self-distortion to include the effects of the magnetic field for frequencies near the gyro frequency. It is shown that the reduction in modulation depth varies only slowly with wave frequency near the gyro frequency, and shows no resonant-like frequency.

Ionospheric Irregularities Causing Random Fading of Very Low Frequencies. S. A. Bowhill. *J. Atmos. & Terrestrial Phys.*, No. 2, 1957, pp. 91–101. 13 refs. USAF-sponsored evaluation of the extent of the changes by finding the correlation coefficients for three pairs of quantities measured experimentally at 75 and 150 kc./sec. frequency. These are: (a) the signal amplitude at two horizontally separated receivers, (b) the amplitudes of the first and second reflections, and (c) the amplitude and phase of the first reflection.

Kolebaniia Beskonechnogo Gazovogo Tsilindra s Sobstvennoi Gravitatsiiei v Magnitnom Pole. I. M. Iavorskaia. *AN SSSR Dokl.*, June 11, 1957, pp. 988–990. In Russian. Study of the oscillation of an infinite self-gravitating gas cylinder in the presence of a magnetic field.

Ionization in the Trail of High-Velocity Pellets. William S. Partridge and L. Dale Harris. *J. Appl. Phys.*, Nov., 1957, pp. 1,269–1,271. OOR-sponsored observations indicating that aluminum pellets do not produce ionization at velocities below approximately 2.9 km./sec., while magnesium leaves an ionized trail at velocities down to approximately 1.6 km./sec. and lithium-magnesium alloy down to approximately 1.3 km./sec.

Ionization by Ultra-Speed Pellets. Charles D. Hendricks, Jr. *J. Appl. Phys.*, Nov., 1957, pp. 1,339–1,341. 22 refs. OOR-supported test results indicating that the ions come from thermal ionization behind the pellet shock waves and from oxidation reactions involving material ablated from the pellets.

Time Lag Between High-Speed Pellets and the Ionization in Their Trails. R. A. Davidson and W. S. Partridge. *J. Appl. Phys.*, Nov., 1957, pp. 1,304–1,308. OOR-supported measurements indicating that the ionization and the luminous region occur simultaneously, and that the variations of this time lag as a function of velocity are explained by some thermodynamic properties of the metal in the pellet.

Funktsii Raspredeleniia dlia Klassicheskogo Elektronnogo Gaza. S. V. Tiablikov and V. V. Tolmachev. *AN SSSR Dokl.*, June 21, 1957, pp. 1,210–1,213. In Russian. Calculation of distribution functions for the classic electron gas.

K Voprosu o Sviazi Mezhdu Obychnymi i Izotopicheskimi Prostranstvami. G. A. Sokolik. *AN SSSR Dokl.*, June 21, 1957, pp. 1,206–1,209. In Russian. Discussion of the connection between ordinary and isotopic spaces.

Teoriia Techeniia Gaza v Poristom Tele v Okoloknudsenovskoi Oblasti; Psevdomolekuliarnyi Potok. B. V. Deriagin and S. P. Bakanov. *AN SSSR Dokl.*, July 11, 1957, pp. 267–270. In Russian. Development of a theory of gas flow through a porous body in the neighborhood of the Knudsen region.

Future Circuit Aspects of Solid-State Phenomena. Edward W. Herold. *IRE Proc.*, Nov., 1957, pp. 1,463–1,474. 25 refs. Discussion of several specific phenomena of interest to circuit and device engineers, namely, superconductivity, molecular amplification, magnetic effects in semiconductors, and nonlinear capacitance in junctions.

Power Plants

Apercus sur les Propulseurs Aéronautiques. Pierre Philippe Chaffiotte. *Tech. & Sci. Aéronautiques*, Sept., 1957, pp. 101–121. In French. Study of the economical aspects and technical characteristics of aircraft power plants. Includes: consideration of turbo-engines for helicopters and VTOL aircraft, nuclear propulsion, noise, and performance comparison.

Jet and Turbine

Niestateczna Praca Silnika Odrzutowego i jej Wptyw na Konstruckje Sprezarek. Stefan Szczeciński. *Tech. Lotnicza*, July-Aug., 1957, pp. 110–114. 14 refs. In Polish. Discussion of unstable working conditions of a jet engine and of their influence on compressor design.

The Post War Development of the Axial Compressor in Great Britain. A. D. S. Carter. *France, ONERA, J.I.S.A., Paris, May 27–29, Comptes Rendus, Pt. 2*, pp. 23–40. Review of problems encountered in compressor development such as those associated with badly shaped surge lines, the development of the actuator disc theory, blade failures, and the effect of inlet maldistribution on compressor performance.

A Second Century of Avons. *The Aeroplane*, Oct. 11, 1957, pp. 552, 553, 556, 557, cutaway drawing. Consideration, including design genealogy, of the 200 series Avons, having both civil and military applications.

Aircraft Engines in 1957. *Interavia*, Oct., 1957, pp. 1,029–1,033. List of the world's major aircraft power units either in production or at a stage of development where production can start shortly.

Rolls-Royce Avon 200 Series. *Flight*, Oct. 11, 1957, pp. 569–574, cutaway drawing.

The Power for Supersonic Flight. *Interavia*, Oct., 1957, pp. 1,026–1,028. Discussion suggesting that the turbojet is likely to maintain its dominent position in aviation for at least the next decade, due to favorable power/weight ratio and simple structure.

Producing a Gas Turbine Fuel Pump. Arnold Warren. *Ind. Aeronautics*, Sept., 1957, pp. 24–27. Evaluation of the small, 14 lb. Lucas-Rotax fuel pump capable of pumping up to 975 gals. per hour at pressures up to 2,000 psi at its maximum speed of 4,000 r.p.m. Depending on its calibration, it can be rated up to a service life of 750 hours.

The Turbine Engine in Salt Atmosphere Operation. F. Herbert Sharp. *Aero. Eng. Rev.*, Jan., 1958, pp. 47–49, 56. Investigation to determine the harmful effects of salt on jet and turboprop engines and to develop methods of minimizing these effects.

Experimental Investigation of Cermet Turbine Blades in an Axial-Flow Turbojet Engine. William C. Morgan and George C. Deutsch. *U.S., NACA TN 4030*, Oct., 1957. 20 pp. Results for 16 tests in which blade life of 150-hours at maximum turbine speed and exhaust temperature is obtained.

Investigation of Some Mechanical Properties of Thermenol Compressor Blades. Donald F. Johnson. *U.S., NACA TN 4097*, Oct., 1957. 14 pp. Tests comparing the bending and torsional, damping, corrosion, and fatigue properties of similar stainless steel and thermenol compressor blades of AISI type 403.

Rocket

Rocket Propulsion Units. Vernet-Lozet. *Interavia*, Aug., 1957, pp. 799–801. Discussion of various types of rocket power plants, their propellants, and characteristics of some of these propellants.

Production

Metalworking

Klejenie Metali. I. Tadeusz Wiślicki. *Tech. Lotnicza*, July-Aug., 1957, pp. 115–122. In Polish. Discussion of various bonding techniques for aircraft application and of bonding materials.

O Zakonomernostiakh Volocheniia Metallov v Prisutstvii Smazok. S. Ia. Veiler and V. I. Likhtman. *AN SSSR Dokl.*, June 21, 1957, pp. 1,224–1,227. In Russian. Derivation of laws governing the drawing of metals in the presence of lubricants.

Cutting Material and Machining Costs with Power Roll Forming. E. W. Bartle. *Tool Engr.*, Nov., 1957, pp. 107–110. Description of the power roll forming process and discussion of the results of recent development tests on a variety of parts.

How to Drill 6AL-4V Titanium Alloy. G. P. Campbell and A. Searle. *Mech. Eng.*, Nov., 1957, pp. 1,025–1,028. Presentation of portable-power-feed drilling and free-hand drilling test procedures.

Barrel Finishing Operation Improves Fatigue Strength of Jet Engine Parts. J. D. Marble and C. V. Ruehrwein. *Tool Engr.*, Nov., 1957, pp. 99–101. Description of tests of seven different finishing processes, with results indicating the relationships between surface finish and fatigue strength.

A Machine for Making Reproductions Without Contact; Application to the Manufacture of Turbine Blades. Roland Moreau. *(Tech. et. Sci. Aéronautiques*, No. 5, 1956, pp. 221–225.) *Gt. Brit., RAE Lib. Transl. 680*, July, 1957. 8 pp. Details of a machine to produce profiles and shapes of any given design.

Nonmetalworking

Metal Bonding of Assemblies for the Canadair CL-28. Jason J. Waller. *Ind. Aeronautics*, Sept., 1957, pp. 15–20. Discussion of a joining method which (1) eliminates 1000 lbs. of structural weight, (2) affords a much longer fatigue life for certain critical assemblies, and (3) gives high speed aircraft a smoother surface when considered from the viewpoint of the aerodynamicist.

Production Engineering

I—Analiza Pracy Lotniczych biur Konstrukcyjnych. II—Technologic Pracy w Biurach Konstruckcyjnych Budowy Samolotów. Marian Wasilewski. *Tech. Lotnicza*, May-June, July-Aug., 1957, pp. 81–88, 123–128. 20 refs. In Polish. Discussion of the working process in an aircraft design office.

An Appreciation of Ultrasonic Flaw Detection Methods. I. R. Smith. *SLAE J.*, Sept., 1957, pp. 8–11. Consideration of ultrasonic nondestructive testing methods, and presentation of results of an investigation to evaluate the method prior to its application.

The Use of Gamma and X-Rays in Aircraft Inspection. I. Grant-Murray. *SLAE J.*, Sept.,

XUM

Four new
MOTORS for MISSILES
by EEMCO

EEMCO TYPE D-978

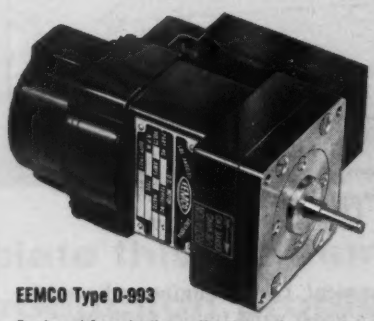
Designed by EEMCO for missile application where prolonged testing is required under full load at a temperature range of +180° F. to +400° F. **SPECIFICATIONS: Volts:** 27 volts DC (24 to 32 volt range). **Horsepower:** ¼ HP (⅔ HP max. short time overload). **R.P.M.:** 12,000. **Weight:** 2.75 pounds. **Military Specifications:** Radio noise filter meets MIL-I-6181B. Explosion proof requirement meets MIL-5272A-Proc. 2. **Altitude Operation:** Tested successfully at over 200,000 feet altitude. **Features:** Built for high shock and vibration loading.

To design and produce motors for missiles that perform well beyond the limits of military specifications yet which maintain specified size and weight limitations is a constant objective at EEMCO. The design, development and testing of motors that achieve these extreme performance characteristics requires EEMCO to conduct company-financed independent research far beyond that normally conducted by a manufacturer of its size. In many instances EEMCO has been able to meet rigid specifications, in fact exceed them, when other producers have failed. For example, three of these extremely rugged new EEMCO motors illustrated will perform with reliability in the atmospheric conditions encountered at altitudes in excess of 200,000 feet, and they are built for unusually high shock and vibration loading. Please note the outstanding capabilities of the individual motors shown.

EEMCO Type D-1022

Designed by EEMCO for extremely high altitude operation with ambient temperature capacity to 165° F. Type D-1022 is capable of unusually high shock and vibration loading.

SPECIFICATIONS: Volts: 56 volts DC. **Horsepower:** 8.5 HP at 85% efficiency. **R.P.M.:** 12,000. **Duty cycle:** Two minutes. **Ambient temperature:** 165° F. **Weight:** 14.75 pounds. **Military Specifications:** Explosion proof requirement meets MIL-5272A-Proc. 2. **Features:** Built for high shock and vibration loading.



EEMCO Type D-993

Designed for missile applications where prolonged testing is necessary. Type D-993 will stand long idling periods with intermittent loads up to 1.25 HP. It is capable of withstanding vibrational accelerations of up to 125 "G's" in a frequency spectrum of 30 to 300 cycles per second.

SPECIFICATIONS: Volts: 28 volts DC (24 to 32 volt range). **Horsepower:** .65 HP. **R.P.M.:** 9600 RPM. **Weight:** 6.2 pounds. **Military Specifications:** Radio noise filter meets MIL-I-6181B. Explosion proof requirement meets MIL-5272A-Proc. 2. **Altitude Operation:** Tested successfully at over 200,000 feet altitude. **Features:** Built for high shock and vibration loading.

EEMCO Type D-899

Rated at 2.75 HP on continuous duty, EEMCO Type D-899 200-volt 400-cycle 3-phase motor is made with high temperature insulation allowing continuous operation at 3.5 HP or a correspondingly high ambient. D-899 contains an integral gear box.

SPECIFICATIONS: Volts: 200 volts, 400 cycle, 3-phase. **Load:** 2.75 HP continuous duty. **R.P.M.:** 3140 RPM. **Power Factor:** 83%. **Overall Efficiency:** 76% for entire unit including gear box. **Military Specifications:** Meets MIL-M-7969A (ASG). **Weight:** 11.25 pounds. **Features:** Type D-899 may be made splash- and drip-proof with minor alterations. Gear box, acting as motor support, places base at approximately the center of gravity of a motor-pump assembly thereby limiting extreme shocks and vibrations encountered in a missile.

EEMCO HAS DESIGNED and produced motors and actuators for missiles and aircraft exclusively for the past 15 years. It has made nothing else. Exhaustive research and testing aimed at perfection in the art of building these units has been a constant objective since EEMCO was founded. As a result, extreme precision and reliability has been attained in its products; therefore many of the latest missiles and aircraft being developed and manufactured for our Armed Forces today contain EEMCO motors and/or actuators.

Your inquiry is invited.

EEMCO ELECTRICAL ENGINEERING & MANUFACTURING CORP.

4612 West Jefferson Boulevard, Los Angeles 16, California—Telephone REpublic 3-0151

DESIGNERS AND PRODUCERS OF MOTORS, ROTARY AND LINEAR ACTUATORS . . . EXCLUSIVELY!

3-953

1957, pp. 3–7. Consideration of a Thulium 170 Isotope as a piece of experimental equipment for evaluating the use of radiography as an additional tool for the inspection of aircraft during maintenance.

Rotor-Disc Comparator. L. W. Nickols. *Aircraft Prod.*, Nov., 1957, pp. 450–455. Presentation of a new instrument for measuring automatically the pitch-errors of the fir-tree form blade-root errations.

Tooling

Automatic Setting. Peter J. Farmer. *Aircraft Prod.*, Nov., 1957, pp. 456–466. Presentation of a completely automatic method of setting jig-borer slides at preselected positions.

Welding

Shielding Gases for Inert-Gas Welding. W. H. Helmbrecht and G. W. Oyler. *Welding J.*, Oct., 1957, pp. 969–979. Review of recent developments in inert-gas-shielded arc welding, and recommendations on the best-suited shielding gas for the inert-gas welding of all metals of commercial importance.

Stress Relieving of Weldments. Earl R. Parker. *Welding J. Res. Suppl.*, Oct., 1957, pp. 433-s–441-s. 23 refs. Summary of current knowledge concerning the origin, nature, and effect of residual stresses and the influences of thermal and mechanical stress-relieving treatments on the service performance of welded structures.

Machining and Welding Titanium. Larry B. Gray. *Ind. Aeronautics*, Sept., 1957, pp. 20–23. Development of a chamber and control gear capable of doing automatic longitudinal and circumferential welds consistently. The majority of the manipulations required while welding are controlled from a panel outside the chamber.

Rocket Sleds

NOTS. Joseph Trocchia. *ARMA Eng.*, Oct.-Nov., 1957, pp. 4–9. Application of the rocket sled to the testing of initial quidance equipment. The discussion includes a description of the data link, instrumentation, track operation, and the data reduction program.

Rotating Wing Aircraft

Vertolet Mi-1 i Upravlenie im—Gorizontal'nyi Polet. R. Kaprelian. *Kryl'ia Rodiny*, Aug., 1957, pp. 24–27. In Russian. Discussion of the horizontal flight of the Mi-1 helicopter.

L'Evolution de l'Hélicoprère. M. Petit. *Tech. & Sci. Aéronautiques*, Sept., 1957, pp. 135–141. In French. Historical development of the helicopter including its actual and future utilization. The structural weight problem and specific power of the engine are also discussed.

The Doman LZ 5-2. *AHS Newsletter*, Oct., 1957, pp. 2–6. Description of the Doman rotor system and its application to a seven-passenger helicopter.

Future of the Whirly Birds. B. L. Whelan. *Air Line Pilot*, Nov., 1957, pp. 4–6, 21. Discussion in terms of eliminating the ride to the airport; transporting oil rigs; government service; and executive transport potential.

Space Travel

On Poland's Participation in the Third International Geophysical Year 1957/58. Tadeusz Olczak. *Polish Acad. Sci. Rev.*, Jan.-June, 1957, pp. 42–53.

Izmerenie Davleniia v Verkhnei Atmosphere. V. V. Mikhnevich. *Uspekhi Fiz. Nauk*, No. 1b, Sept., 1957, pp. 197–204. In Russian. Analysis of data and description of apparatus used for pressure measurements in the upper atmosphere.

Zadacha Izmereniia Davleniia i Plotnosti Vysokikh Sloev Atmosphery s Pomoshch'iu Iskusstvennogo Sputnika Zemli. B. S. Danilin, V. V. Mikhnevich, A. I. Repnev, and E. G. Shvidkovskii. *Uspekhi Fiz. Nauk*, No. 1b, Sept., 1957, pp. 205–225. 34 refs. In Russian. Discussion of the role of an artificial earth satellite in the study of pressure, density, temperature, and composition of the upper atmosphere.

Visibility of Artificial Satellites of the Planet Earth. Ingeborg Schmidt. (*Aero Med. Assoc., 28th Annual Meeting, Denver, May 8, 1957.*) *J. Av. Med.*, Oct., 1957, pp. 435–446. 13 refs. Calculation of spaces of potential visibility in eight oblique meridians.

Space Travel: A Symposium. *J. Av. Med.*, Oct., 1957, pp. 479–512. 14 refs. (*Aero. Med. Assoc., 28th Annual Meeting, Denver, May 8, 1957.*) *Partial Contents:* Introduction, Paul A. Campbell. The Propulsion Engineer's Views, Konrad K. Dannenberg. The Astronomer's Views, Walter Orr Roberts. The Astrophysicist's Views, Heinz Haber. A Test Pilot's Viewpoint, A. Scott Crossfield. Instrumentation for Space Flight, George W. Hoover. Some Survival Aspects of Space Travel, Alfred M. Mayo. The Vanguard Project, John P. Hagen. The Possibilities of an Inhabitable Extraterrestrial Environment Reachable from the Earth, Hubertus Strughold.

Izmerenie Kontsentratsii Polozhitel'nykh Ionov Vdol' Orbity Iskusstvennogo Sputnika Zemli. K. I. Gringauz and M. Kh. Zelikman. *Uspekhi Fiz. Nauk*, No. 1b, Sept., 1957, pp. 239–252. 23 refs., In Russian. Measurement of the concentration of positive ions along the orbit of an artificial earth satellite.

Issledovanie Tverdoi Sostavliaiushchei Mezplanetnogo Veshchestva s Pomoshch'iu Raket i Iskusstvennykh Sputnikov Zemli. S. M. Poloskov and T. N. Nazarova. *Uspekhi Fiz. Nauk*, No. 1b, Sept., 1957, pp. 253–265. In Russian. Investigation of the solid interplanetary matter by means of rocket and earth satellite measurements.

Izmerenie Elektrostaticheskikh Polei v Verkhnikh Sloiakh Zemnoi Atmosfery. I. M. Imianitov. *Uspekhi Fiz. Nauk*, No. 1b, Sept., 1957, pp. 267–282. 14 refs. In Russian. Measurement of electrostatic fields in the upper layers of the atmosphere.

Weightlessness. Siegfried J. Gerathewohl. *Astronautics*, Nov., 1957, pp. 32–34, 74, 75. Discussion of the physical principles of weightlessness, how it is achieved in an aircraft, and an account of human reactions to this phenomena.

Raketnye Issledovaniia Sostava Atmosphery na Bol'shikh Vysotakh. B. A. Mirtov. *Uspekhi Fiz. Nauk*, No. 1b, Sept., 1957, pp. 181–196. 16 refs. In Russian. Discussion of data on the composition of the upper atmosphere obtained from rocket measurements.

Issledovaniia Korotkovolnovogo Ul'trafioletovogo Izlucheniia Solntsa. S. L. Mandel'shtam and A. I. Efremov. *Uspekhi Fiz. Nauk*, No. 1b, Sept., 1957, pp. 163–180. 24 refs. In Russian. Discussion of the importance of artificial earth satellites in the study of short-wave ultraviolet solar radiation.

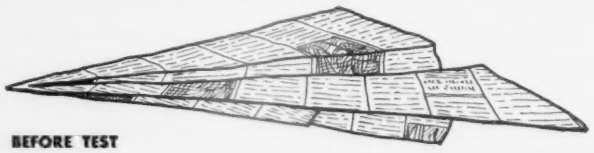
Issledovanie Variatsii Kosmicheskogo Izlucheniia. S. N. Vernov, Iu. I. Logachev, A. E. Chudakov, and Iu. G. Shafer. *Uspekhi Fiz. Nauk*, No. 1b, Sept., 1957, pp. 149–162. 12 refs. In Russian. Investigation of the possibility of using the artificial earth satellite to study the variations of cosmic radiation.

L'Anno Geofisico Internazionale 1957–1958. Giorgio Fea. *Riv. Aero.*, Sept., 1957, pp. 1,057–1,076. In Italian. Discussion covering the International Geophysical Year with description of the contributions of the Italian Air Force meteorological program.

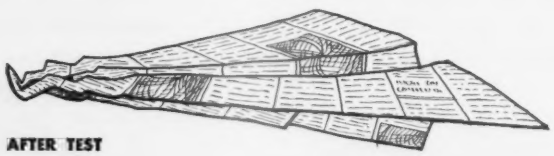
A New Realm of Flight. *Flight*, Oct. 18, 1957, pp. 611–614. General discussion of the principles underlying the launching of the first man-made

NOTABLE ACHIEVEMENTS IN WIND TUNNEL TESTING— NO. 3

CWT engineers are a dedicated group, spending many extra-curricular hours in the pursuit of basic scientific information. The result of a recent test is shown below.



BEFORE TEST



AFTER TEST

Equipped For Action

For aerodynamic testing and development, CWT's engineers have at their command one of the nation's finest wind tunnel facilities.

For example, CWT engineers utilize three interchangeable test carts, high speed on-line computing systems, and a new automatic pressure data metering system. Facilities such as these, in combination with a skilled and versatile staff, have helped the CWT build a reputation for quality and efficiency known throughout the world.

In addition to its owner companies, the CWT also serves other leading aircraft firms and government agencies.

If you would like more information concerning the facility, please write us.

CWT
SOUTHERN CALIFORNIA COOPERATIVE WIND TUNNEL
950 S. Raymond Ave., Pasadena, California

Operated by the California Institute of Technology. Owned by Convair, Douglas, Lockheed, McDonnell and North American.

You'll appreciate this craftsman most when your production problems are worst

. . . because he and the other members of the precision production team at the Mechanical Division of General Mills have the talent and tools to take your most complex production assignments in stride.

These are the areas in which our manufacturing capabilities can serve you best:

- precision mechanical devices
- electro-mechanical sub-systems or assemblies
- electronic component assemblies
- fine-pitch, instrument-type gears and gear trains

We can start from any stage of your production assignment: from the mere statement of a problem to be solved to a completed design.

You'll receive the kind of engineering and manufacturing you'd be proud to call your own. (Many times in 17 years of ordnance and instrument work we've improved upon the original design of devices we've been assigned to produce.)

You'll get on-time delivery—enabling you to meet your own target date.

We'll be happy to serve you today—or when your production problems become really tough.

GET MORE FACTS—Send for booklet. It shows our facilities, names our customers, introduces you to on-time delivery. Write Dept. AE-2, Mechanical Division, General Mills, 1620 Central Ave. N. E., Minneapolis 13, Minn.

General Mills

MECHANICAL DIVISION

INTELLIGENT ENGINEERING AND PRECISION MANUFACTURING

XUM

ENGINEERS *Aerodynamics & Propulsion*

Information manual about APL and its current programs now available

The Applied Physics Laboratory (APL) of The Johns Hopkins University is unique in that we are neither an industrial nor an academic organization, but rather a composite, having drawn freely from the methodologies of each.

For thirteen years APL has pioneered in guided missiles. Today we are engaged in a broad program of R & D for the Navy; in addition, we are responsible for technical direction of industrial and academic contractors in developing the Terrier, Talos and other major weapons and weapons systems. Our staff members enjoy not only the stimulus of association with their immediate colleagues at APL, but also with those in other organizations of considerable stature.

NEW 30-PAGE PUBLICATION

A few positions for senior engineers and scientists are now open. Information on our accomplishments and goals is available in a new 30-page publication, just off the press.

In it staff leaders representing each of the various disciplines and fields outline the nature of their programs. Information on our new laboratory in Howard County, Md. (equidistant between Baltimore and Washington) is also included, together with facts on the outstanding communities in which our staff members live.

Quantity is somewhat limited. May we suggest you send now to:
Professional Staff Appointments

The Johns Hopkins University
Applied Physics Laboratory

8605 Georgia Avenue Silver Spring, Md.

satellite, and quotations concerning the achievement.

Rockets and the International Geophysical Year. A. V. Cleaver. *Air BP*, No. 4, 1957, pp. 2–4. General discussion of the rocket development.

Space Travel–Science or Fiction?. M. N. Golovine. *Hawker Siddeley Rev.*, Sept., 1957, pp. 88–91. Description of some basic astronautical concepts and of some practicable projects.

Systems; Satellites; Space: Russian Launching of Earth Satellite Focuses New Interest on Problems of Space Navigation. John M. Slater and Jack M. Wuerth. *Mil. Electronics*, Oct., 1957, pp. 24–27. Elemental discussion of the future of satellites, gains of satellite take-off, the problem of "meeting" in space, landing problems, the handling of data, and the practical problems of mechanization.

Rakety i Iskustvennye Sputniki Zemli v Issledovaniiakh Verkhnei Atmosphery. E. K. Fedorov and G. A. Skuridin. *AN SSSR Vestnik*, Aug., 1957, pp. 37–48. In Russian. Discussion covering rockets and artificial satellites and studies of the upper atmosphere. Includes description of the IGY program, with details of equipment and instrumentation used and problems encountered.

Problems of Launching an Earth Satellite. I, II. Martin Summerfield. *Astronautics*, Nov., Dec., 1957, pp. 18–21, 86–88; 34–36, 50, 51, 54. Discussion which includes orbit selection, launching energy requirements, frontal area density effects, and choosing an orbital altitude. An analysis is presented of flight performance, multistage techniques, and firing program for a vehicle capable of putting a 50-lb. payload on the moon.

Ein Vergleich möglicher Antriebssysteme für Raumfahrzeuge. George P. Sutton. *Raketentech. & Raumfahrtforsch.*, Oct., 1957, pp. 73–75. 12 refs. In German. Discussion of the actual propulsion systems for space vehicles including liquid power plants, nuclear propulsion, free radical (atomic gases), heating through solar energy, and electrical discharge and Lorin propulsion.

Entwicklungsstand der Vanguard-Rakete. *Raketentech. & Raumfahrtforsch.*, Oct., 1957, pp. 79–81. In German. Presentation of charts and discussions on the Vanguard rocket.

Ispol'zovanie Iskusstvennykh Sputnikov Zemli dlia Proverki Obshchei Teorii Otnositel'nosti. V. L. Ginzburg. *Uspekhi Fiz. Nauk*, No. 1a, Sept., 1957, pp. 119–122. In Russian. Discussion covering the use of artificial earth satellites in the verification of the general theory of relativity.

Why Earth Satellites? S. E. Singer. *Air BP*, No. 5, 1957, pp. 15–18. Elemental explanation of the IGY satellite program stating that the prime purpose of the satellite is to serve as an observatory above the earth's atmosphere and to investigate the space which forms the environment of the earth.

Structures

Ustoichivost' Sterzhnei i Plastinok v Usloviiakh Polzuchesti. Iu. N. Rabotnov and S. A. Shesterikov. *Prikl. Mat. i Mekh.*, May-June, 1957, pp. 406–412. In Russian. Study covering the problem of stability of a bar or a plate in the presence of creep.

Bars & Rods

Beitrag zur Berechnung räumlich gekrümmter Stäbe nach der Theorie erster Ordnung. R. Trostel. *Ing.-Arch.*, No. 6, 1957, pp. 414–423. In German. Calculation of spatially bent bars using the first order theory.

Cylinders & Shells

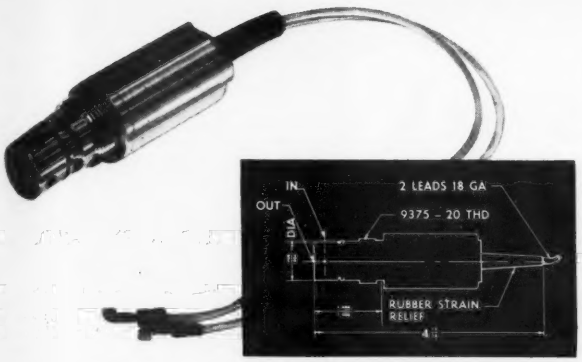
Biegetheorie der Rotationsschale mit flacher, kreisförmiger Erzeugender. R. Windels. *Ing.-Arch.*, No. 3, 1957, pp. 164–173. In German. Analysis of the theory of bending indicating that the introduction of some approximations provides means for determining the state of stress of rotating cylinders with circular generatrix.

An Approximation Formula for the Torsional Resistance of a Multicellular, Thin-Walled, Hollow Prism. H. Wittmeyer. (*ZAMM*, Nr. 11/12, 1956, pp. 436–443.) *Gt. Brit., RAE Lib. Transl. 683*, Aug., 1957. 12 pp. 16 refs. Development of a formula in which the torsional resistance is obtained as the largest eigenvalue of an algebraic eigenvalue problem. A lower bound can be given by the use of Rayleigh's principle.

Allgemeine Stabilitätstheorie der Schalen. G. Schwarze. *Ing.-Arch.*, No. 4, 1957, pp. 278–291. In German. Presentation of a general stability theory of shells and development of the general differential stability equations and pertinent variational problems using the conventional methods of shell statics.

Variatsionnye Zadachi v Nelineinoi Teorii Uprugikh Obolochek. L. Ia. Ainola. *Prikl. Mat. i Mekh.*, May-June, 1957, pp. 399–405. In Russian. Study of the variational problem in the nonlinear theory of elastic shells.

Die Auswölbungen der Kreis- und Kreisringmembranen unter hydrostatischem Druck. K. Karas. *Ing.-Arch.*, No. 5, 1957, pp. 359–380. In German. Includes consideration of the deformation of circular ring membranes under hydrostatic pressure.



Proven Valve Performance

. . . is behind the development and precision production of this K-W high pressure air or hydraulic solenoid valve. Only minimum mounting space is required for this valve whose two closely spaced annular ports are seperated by face sealed "O" rings. Operating up to 3000 psi. at 17 to 30 volts DC in a -65° to 165° F. ambient range, this is but one of many valve and solenoid applications developed by Koontz-Wagner for the aviation industry. If your problems include the need for design and production of specialized electro-mechanical devices, write:

MANUFACTURING DIVISION

KOONTZ WAGNER
ELECTRIC COMPANY INCORPORATED

518 N. MICHIGAN ST. • SOUTH BEND, INDIANA

When you write to manufacturers
whose advertising appears
in the
Aeronautical Engineering Review,
it will be
of interest to the companies
and of benefit to the Institute if you
mention that you saw it
in the
Aeronautical Engineering Review

Supercharger engineer

Leading AIRCRAFT PARTS manufacturer (New York area) currently establishing cabin supercharger overhaul program.

Seeking experienced managing executive engineer capable of supervising complete project.

This position offers attractive salary with top management benefits and responsibilities.

All replies kept in strict confidence.

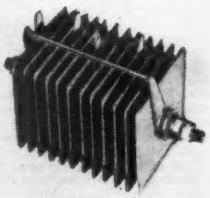
Write: Box 848
AERONAUTICAL ENGINEERING REVIEW
2 East 64th Street
New York 21, N. Y.

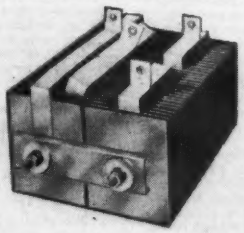
CHATHAM
SELENIUM RECTIFIERS

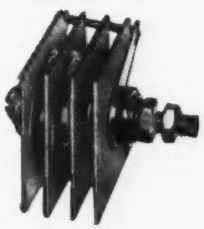
These exclusively Chatham features are the result of years of pioneering achievement in the design, development and production of custom-made selenium rectifiers to specific applications.

Whatever your rectifier requirement—low voltage and high current, high voltage and low current or any other combination—Chatham's unapproached experience in this highly specialized field is readily yours. Please contact Engineering Department. Chatham Electronics, Livingston, N. J.

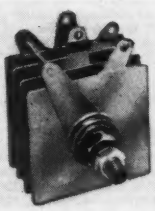
Lighter
Smaller
Stronger







Unexcelled in Performance



CHATHAM ELECTRONICS
division of
TUNG-SOL ELECTRIC INC.

General Offices and Plant: Livingston, N. J.
Sales Offices:
CHICAGO, DALLAS, LIVINGSTON, LOS ANGELES

Elasticity & Plasticity

O Zakonakh Plastichnosti dlia Chastnogo Klassa Putei Nagruzheniia. V. D. Kliushnikov. *Prikl. Mat. i Mekh.*, 1957, pp. 533–543. 14 refs. In Russian. Derivation of a law governing the relation between stresses and deformations leading to the case of isotropic flow theory, sometimes called the Lanning law.

Plasticheskoe Techenie Pologoi Obolochki dlia Osesimmetrichnoi Zadachi. S. M. Feinberg. *Prikl. Mat. i Mekh.*, 1957, pp. 544–549. In Russian. Application of the principle of critical strain to study plastic flow propagating over the surface of an axisymmetric shell under uniform loading and freely supported on its periphery.

Rasprostranenie Voln v Gibkikh Nitiakh (Vlianie Skorosti Deformatsii). N. Kristescu. *Prikl. Mat. i Mekh.*, 1957, pp. 486–490. 10 refs. In Russian. Investigation of the propagation of elasto-plastic waves in elastic filaments, taking into account Rakhmatulin, Riabov, and Kristescu's results.

Uprugo-Plasticheskoe Ravnovesie Klina pri Ploskom Napriazhennom Sostoianii. L. M. Kachanov. *Prikl. Mat. i Mekh.*, May-June, 1957, pp. 413–418. In Russian. Study of the elasto-plastic equilibrium of a wedge in the state of plane stress under the assumption of continuous displacement.

Marin's Strength Hypothesis. A. D. Topping. *J. Aero. Sci.*, Jan., 1958, pp. 59, 60. Critical examination of Marin's hypothesis for describing limiting conditions in materials with different properties in different directions, and different strengths in tension and compression.

Die Matrizentheorie der Statik. J. H. Argyris. *Ing.-Arch.*, No. 3, 1957, pp. 174–192. In German. Revue and extension of the matrix theory of statics of elastic frames. Derivation of the force and deformation methods using single-load and uniform-displacement laws, and extension to linear-elastic systems. Detailed examination of the elasticity and rigidity of a frame and static calculation of systems using the force and deformation methods.

Deformation of Solids at High Rates of Strain. A. H. Cottrell. *Chartered Mech. Engr.*, Nov., 1957, pp. 448–460. 45 refs. Discussion in terms of elastic and plastic waves; cracks in semibrittle materials; heating effects; slip in crystals; centers of dislocations; yield points; yield and fracture at low temperature; delayed yield; and fracture at temperatures above 0°K.

Plates

K Nelineinoi Teorii Tonkikh Plastin. N. F. Morozov. *AN SSSR Dokl.*, June 11, 1957, pp. 968–971. 11 refs. In Russian. Study of the nonlinear theory of thin plates with emphasis on the problem of the existence of a solution for the case of bending, taking into account Panov, Friedrichs, and Stoker's results.

Finite Bending of a Plate into a Spherical Shell. B. R. Seth. *ZAMM*, Sept.-Oct., 1957, pp. 393–398. Application of the theory of finite deformation to show that a circular plate of radius d can be bent into a spherical shell by forces and couples applied to the edges only, the inner surface a and the outer surface b of the shell being free from tractions.

Beitrag zur Berechnung in Querrichtung durchlaufender Plattenstreifen mit Hilfe Fourierscher Integrale. F. W. Mader. *Ing.-Arch.*, No. 3, 1957, pp. 201–204. In German. Development of a method for the calculation of plate strips using Fourier integrals.

Tension of an Infinite Plate Cut Along a Circular Arc. R. C. T. Smith. *J. Math. & Phys.*, Oct., 1957, pp. 223–233. Determination of the stress distribution in an infinite plate cut along the unit circle, the cut being lubricated by a thin layer which transmits normal tensions but has no resistance to tangential shears.

Einflussflächen einer Dreiecksplatte mit Aufpunkt am freien Rand. A. Scherer. *Ing.-Arch.*, No. 4, 1957, pp. 255–272. In German. Derivation of singular solutions and extension of the Schultz-Grunow method to the case of plates with partly free and clamped edges with load applied on the free edge.

Sandwich Structures

New Fasteners for Honeycomb. Raymond J. Schwab. *Missile Des. & Devel.*, Nov., 1957, pp. 12, 13, 15. Presentation of recent fastening techniques, including (1) wood or metal strips between the skin covers, (2) molded-in plastic blocks, (3) bonded-in insert, and (4) aluminum spacer through inserts.

Testing

Big Test—In a Hurry. *Hawker Siddeley Rev.*, Sept., 1957, pp. 77–80. Use of 1,350 strain gauges and 20 miles of electric cable in the structural testing of the Javelin.

Thermal Stress

Thermal Stresses in a Circular Bulkhead Subjected to a Radial Temperature Distribution. Marvin Forray and Melvin Zaid. *J. Aero. Sci.*, Jan., 1958, pp. 63, 64. Analysis of thermal stresses in a circular bulkhead consisting of a web and cap assembly. The case of parabolic temperature distribution which includes linearly varying and unform temperatures is considered in detail.

Bemerkungen zur Frage des Wärmeschocks im Flugzeugbau. F. Bollenrath. (*NATO AGARD Gen. Assembly, Brussels, Aug. 27, 1956.*) *DVL Bericht No. 30*, June, 1957. 24 pp. Westdeutscher Verlag, Köln & Opladen. In German. Study of the thermal shock problem in aircraft structures. The case of a plate between two high-speed flows—one of hot, the other of cold gas—is considered. The pressure distribution dependent on time and plate thickness is calculated for various structural materials.

Structural Problems in Hypersonic Flight. Samuel B. Batdorf. (*ARS Semi-Annual Meeting, San Francisco, June 10–13, 1957.*) *Jet Propulsion*, Nov., 1957, pp. 1,157–1,161. 12 refs. Discussion emphasizing that improvements in high temperature strength are generally associated with reduction in ductility so that thermal shock becomes a problem. There does not appear to be a single "best way" to solve these difficulties, but rather a combined attack is needed, in which material properties, structural design, and evasive tactics such as cooling are carefully optimized.

Buckling at High Temperature. N. J. Hoff. *RAeS J.*, Nov., 1957, pp. 756–774. 47 refs. OSR-supported survey of known solutions to problems arising, and presentation of new theories of creep buckling of columns and of thin circular cylindrical shells.

Creep Buckling of Tubes in Torsion. Iain Finnie. *J. Aero. Sci.*, Jan., 1958, pp. 66, 67. Extension of the time-dependent modulus approach to other types of buckling, and its application to compare the prediction of torsional buckling with experiment.

Vremia do Razrusheniia Vrashchaiushchegosia Diska v Usloviiakh Polzuchesti. V. I. Rozenblium. *Prikl. Mat. i Mekh.*, May–June, 1957, pp. 440–444. In Russian. Study of the lifetime of a rotating disc in the case of creep.

Weight Analysis & Control

Abschätzung des Flügelgewichtes. R. Schoeffel and K. L. Sanders. *Luftfahrttechnik*, Oct. 15, 1957, p. 224. In German. Derivation of an empirical formula for calculating the weight of the wing, including flaps and/or ailerons, for light-metal constructions. This formula is used for calculating the preliminary design and is applicable to swept and delta wing.

Wings

A Study on Swept Rectangular Plate. Shinichi Zuzuki. *Japan Soc. Aero. Eng. J.*, Oct., 1957, pp. 1–6. In Japanese. Review of theoretical and experimental studies, including Reissner and Martin methods. A two-dimensional approach is introduced and several assumptions are made.

Thermodynamics

Vychislenie Teploty i Entropii Adsorbtsii po Odnoi Izoterme Adsorbtsii. B. P. Bering and V. V. Serpinskii. *AN SSSR Dokl.*, June 21, 1957, pp. 1,254–1,256. In Russian. Calculation of the heat and entropy of adsorption from a single adsorption isotherm.

Heat Transfer

Teplovaia Konvektsiia vo Vrashchaiushcheisia Krugloi Trube pri Postoiannom Temperaturnom Gradiente. V. N. Golubenkov. *Prikl. Mat. i Mekh.*, May-June, 1957, pp. 439, 440. In Russian. Study of the thermal convection in a rotating circular tube in the case of a constant temperature gradient.

Rate of Temperature Change of Simple Shapes. Victor Paschkis and J. W. Hlinka. (*ASME Annual Meeting, New York, Nov. 25–30, 1956.*) *ASME, Trans.*, Nov., 1957, pp. 1,742–1,750. Presentation of sample charts with curves showing rate-temperature, rate-time, and temperature-time relationships. Examples of use are given, and limits of the graphs are tabulated.

Nekotorye Termogidrodinamicheskie Zadachi ob Ustanovivshemsia Odnomernom Techenii Viazkoi Kapel'noi Zhidkosti. S. A. Regirer. *Prikl. Mat. i Mekh.*, May–June, 1957, pp. 424–430. 12 refs. In Russian. Study of the steady one-dimensional flow of a viscous liquid with heat transfer, taking into account the effect of temperature and dissipation energy on viscosity.

VTOL & STOL

NACA Flight Tests a VTOL Model. Powell M. Lovell, Jr. *Ryan Reporter*, No. 4, 1957, pp. 12–14, 32, 33. Investigations, including transition, which aided in the development of the Ryan X-13 Vertijet.

Flying the Atar Volant. Auguste Morel. *Interavia*, July, 1957, pp. 713–715. Discussion of a testing program for the French flying platform, and a description of its flight handling characteristics.

Il Problema del Decollo Verticale e della Conversione in Volo. Augusto Baracchini Caputi. *Riv. Aero.*, Sept., 1957, pp. 1087–1102. In Italian. Discussion of the problems of vertical take-off aircraft.

Conceptii noi in Sustentatia Avioanelor s Zborul la Viteze Mici. I. L. Dumitrescu. *Rev. Transp.*, Sept., pp. 402–409. 28 refs. In Rumanian. Discussion of problems of aircraft sustentation, low-speed flight, take-off, and landing.

The Jet VTOL Concept. Herman L. Braasch and R. A. Fuhrman. (*IAS Natl. Naval Aviation Meeting, San Diego, Aug. 5–10, 1957.*) *Ryan Reporter*, No. 4, 1957, pp. 21–25. Studies to determine a feasible method of controlling jet-propelled aircraft at zero speed.

Dynamic Similarity; A Brief Note on the Influence of Scale Factors. Ken S. Coward. *Aircraft Eng.*, Nov., 1957, pp. 343–345. Discussion of power loading and propeller disk loading as scale factors in VTOL model design.

Das Kurzstartflugzeug Dornier Do 27. W. Pleines. *Luftfahrttechnik*, Sept. 15, 1957, pp. 194–205. In German. Characteristics and capacities of the STOL aircraft Dornier Do 27, and results of a critical capacity comparison. Includes the history of the slow aircraft, its limitations, and possible methods of improvement.

Ausschau nach dem zivilen Coleopter. Walter Stender. *Flug-Revue*, Oct. 12, 1957, pp. 21–25. In German. Description of a civil coleopter, with details of its design and operation, and a comparison to conventional aircraft.

Water-Borne Aircraft

Investigation of High Length/Beam Ratio Seaplane Hulls with High Beam Loadings; Hydrodynamic Stability. XIV—The Effect of a Tailored Afterbody on Stability and Spray Characteristics with Test Data on Model J. D. M. Ridland. (*Gt. Brit., MAEE Rep. F/Res/249*, Oct., 1955.) *Gt. Brit., ARC CP 351*, 1957. 40 pp. 16 refs. BIS, New York, $1.08.

Wind Tunnels & Research Facilities

Blow-Down Tunnel. Wallace Umphrey. *Ind. Aeronautics*, Nov., 1957, pp. 37, 38. Description of a Mach 4 tunnel built for Boeing Aircraft.

A Simple Method of Constructing Duct Models for the Electrolytic Tank. J. F. Norbury and A. Platt. *RAeS J.*, Nov., 1957, pp. 775, 776.

Wind Tunnel Instrumentation. A. Tiffany. *Electronic Eng.*, Nov., 1957, pp. 514–518. Description of a fairly simple type of data-handling system in the context of the measurement problems peculiar to wind tunnel practice.

Enduits de Visualisation à Base de Corps Gras. B. Persoz and G. Grenier. *La Recherche Aéronautique*, Sept.-Oct., 1957, pp. 19–22. In French. Description of flow visualization techniques used in the Modane, France, S1 wind tunnel and of coating materials developed to melt at temperatures of 30° or 40°C.

✦ ✦ ✦

IAS SCRIP COUPONS

IAS SCRIP COUPONS may now be used as payment for preprints, dues, subscriptions, and all other IAS services. This method will save you from writing checks, sending money orders or cash. Sheets of 5- and 25-cent coupons are available in book form of $5, $10, $25, or any amount desired, from the Special Publications Dept. Scrip may be ordered by foreign and domestic members and nonmembers.

Aeronautical Reviews — BOOKS

COMPUTERS

Digital Differential Analyzers; An Applications Manual for Digital and Bush Type Differential Analyzers. George F. Forbes. 4th Ed. Pacoima, Calif., G. F. Forbes, 1957. 188 pp., diagrs., tables.

The fourth edition of this manual is essentially the same as the third but with necessary corrections and some slight addition of material. The emphasis is upon the mathematical capabilities and limitations of the equipment and upon the preparation of a schematic which adequately represents the given problem.

CONTROL ENGINEERING

Control Engineering Manual; A Guide to the Practice of Control Systems Engineering, Including System Specification, Synthesis, and Evaluation; Plus a Comprehensive Coverage of Design Techniques and Equipment Important to Automatic Control. Edited by Byron K. Ledgerwood, and the Staff of *Control Engineering*. New York, McGraw-Hill Book Company, Inc., 1957. 189 pp., illus., diagrs., tables. $7.50.

Drawn from articles that appeared in *Control Engineering*, this guide covers specifications of control systems, their synthesis and evaluation, generating control functions, design techniques, analog computers, nonlinearity in control systems, and similar information essential for a thorough understanding of control system engineering. Tests for the evaluation of a designed system are also included, and many practical examples are given.

DOCUMENTATION

Information Systems in Documentation; Based on the Symposium on Systems for Information Retrieval held at Western Reserve University, Cleveland, in April, 1957. Edited by J. H. Shera, A. Kent, and J. W. Perry. (Advances in Documentation and Library Science, Vol. 2.) New York, Interscience Publishers, Inc., 1957. 639 pp., illus., diagrs. $12.

This volume, which presents the proceedings of the symposium, contains some thirty-five papers that describe and demonstrate information systems ranging from those based on traditional library techniques principally involving the arts of card indexing and classification through applications of punched cards and mechanical sorting based on machine coding to prospective applications of photography, telecommunication, telefacsimile and computer-like mechanisms, separately or in combination.

Although automatic or semiautomatic methods for retrieving information are emphasized, cataloging, indexing, and classification systems have not been neglected; thus, the volume consists of six parts: fundamentals in systems design, documentation problems in specialized fields, semiautomatic systems, systems using accounting or statistical machines, systems using computers or computerlike devices, and cooperative information processing.

EDUCATION

Soviet Education for Science and Technology. Alexander G. Korol. New York, John Wiley & Sons, Inc.; Cambridge, Mass., Technology Press of Massachusetts Institute of Technology, 1957. 513 pp. tables. $8.50.

It is the object of Mr. Korol's book to examine the organization and effectiveness of the Soviet Union's formal training process by presenting a general outline of the entire educational system of that country from elementary through graduate school and selectively to illustrate in some detail Soviet training in physics and mechanical engineering. The present volume derives directly from research on Soviet education which was carried out at the Center for International Studies, Massachusetts Institute of Technology.

Contents: (1) The Soviet System of Mass Education. (2) The Ten-Year School: Organization and Curriculum. (3) The Ten-Year School: Instruction, Textbooks, and Examinations. (4) The Secondary Engineering (Industrial) Technical Schools. (5) Soviet Higher Education: The Institutional System. (6) Soviet Higher Education: Selection, Enrollment, and Graduation. (7) Soviet Higher Education: The Academic Plan. (8) Soviet Higher Education: Sample Curricula at an Engineering School (ME), a University (Physics), and a Pedagogical Institute (Mathematics). (9) Soviet Higher Education: Teachers, Textbooks, and Facilities. (10) Soviet Higher Education: The Teaching Process. (11) Soviet Higher Education: The Graduate Training. (12) Comments and Reflections. A Selected Bibliography on the Soviet Educational System. Index of Sources. General Index.

For Information on IAS Library Services, see page 71

Statements and opinions expressed in Book Reviews are to be understood as individual expressions and not necessarily those of the Institute.

ELECTRONICS & ELECTRICITY

Electronic Designers' Handbook. Robert W. Landee, Donovan C. Davis, and Albert P. Albrecht. New York, McGraw-Hill Book Company, Inc., 1957. 1200 pp., illus., diagrs., tables. $16.50.

The entire electronics field is discussed in this handbook for students and practicing engineers which provides design data, procedures, and examples that illustrate the application of the material to specific design problems. The authors are employed in various capacities at Gilfillan Brothers, Inc., Los Angeles, and their combined experience includes association with Air Force radar groups, the Naval Electronics Laboratory at the University of California, and the Submarine Signal Company in Boston.

Solid State Physical Electronics. Aldert van der Ziel. Englewood Cliffs, N.J., Prentice–Hall, Inc., 1957. 604 pp., diagrs. $13.

A clear and comprehensive account of the physics and the operation of vacuum tubes, transistors, and other solid-state devices used in the modern electronics industry. Following introductory chapters to atomic physics, statistics, solid-state structure, and semiconductor theory, the bulk of the presentation is chiefly devoted to electron emission, semiconductor, and dielectric and magnetic devices.

Microwave Measurements. Edward L. Ginzton. New York, McGraw-Hill Book Company, Inc., 1957. 515 pp., illus., diagrs. $12.

This volume is concerned with the basic forms of electrical measurements encountered in the microwave region of the electromagnetic spectrum. Emphasis is placed upon basic topics to the exclusion of specialized fields such as the measurement of dielectric constants, antennas, and transmitter and receiver characteristics. The author, Professor of Applied Physics and Electrical Engineering, Stanford University, has written his text primarily for a first year graduate course in microwave measurements.

Principles of Electrical Measurements. H. Buckingham and E. M. Price. New York, Philosophical Library, Inc., 1957. 600 pp., illus., diagrs. $15.

This presentation of the principles employed in making electrical measurements and the methods of applying these principles also covers the requirements of Final Degree and A.M.I.E.E. examinations, and of Higher National Certificate and Diploma courses in Great Britain. Ranging from indicating instruments and deflectional methods to new measurement techniques, the material includes such topics as potentiometer and bridge methods, instrument transformers, integrating meters, measurements related to power systems, valve methods, measurements of some nonelectrical quantities, resonance and heterodyne measurements, and the cathode ray oscillograph.

Basic Electricity. Rufus P. Turner. New York, Rinehart & Company, Inc., 1957. 396 pp., illus., diagrs. $6.50.

A text for beginning students of electricity. The various topics include alternating current theory, magnetism and electromagnetism, illumination, telegraphy, and telephony, and provide a background for further study in electronics, radio, television, and industrial automation.

HYDRAULICS

Engineering Fluid Mechanics. Charles Jaeger. Translated from the German by P. O. Wolf. New York, St. Martin's Press, Inc., 1957. 529 pp., illus., diagrs., tables. $11.50.

First published in 1949 under the title *Technische Hydraulik*, this book deals with the methods of analysis and calculation required for the design of hydroelectric power installations and engineering. The chief topics under discussion include the physical basis of hydraulics, steady flow, unsteady flow, and ground–water flow, accompanied by numerous references intended to give the reader some insight into the historical development of hydraulics.

INSTRUMENTS

Process Instruments and Controls Handbook; Prepared by a Staff of Specialists. Douglas M. Considine, Editor-in-Chief. New York, McGraw-Hill Book Company, Inc., 1957. 1380 pp., diagrs., tables. $19.50.

A thorough treatment of the operating and design fundamentals of measurement and automatic control systems used in process fields. While not covering any specific industrial use in detail, it reviews the principles of many different types of measurement and control processes; serves as a guide to the selection of instruments and automatic controls for specific jobs; and furnishes formulas, constants, and critical and other engineering data for aid in solving instrumentation problems. Among the subjects covered are: measurement standards, primary elements, measurement systems, indicators and recorders, automatic controllers, timers and program controllers, electric and pneumatic telemetering, final control elements, fundamental principles of process control, and mathematical techniques for solving automatic control problems.

MAINTENANCE

A Guide to the Aircraft Maintenance Engineers' License Examinations. 4th Ed., Revised to October, 1957. Maidenhead, Berkshire, Eng., Society of Licensed Aircraft Engineers, 1957. 119 pp. 10*s*. 6*d*.

MATHEMATICS

Integral Equations and Their Applications to Certain Problems in Mechanics, Mathematical Physics and Technology. S. G. Mikhlin. Translated from the Russian by A. H. Armstrong. (International Series of Monographs on Pure and Applied Mathematics, Vol. 4.) London, New York, Pergamon Press, 1957. 338 pp. $12.50.

This is the first English edition of a work that attempts a systematic treatment of the voluminous material concerning the numerous applications of integral equations. The first part of the book concerns itself with fundamental theory and methods of approximate solution; the second is devoted to practical applications, concentrating in the main on problems in the theory of elasticity and hydrodynamics.

Analytical Conics. Barry Spain. London, New York, Pergamon Press, 1957. 145 pp., diagrs., tables. $5.00.

Designed for the undergraduate and pupils specializing in mathematics, this brief monograph on analytical geometry discusses the straight line, the circle, and conics in their standard forms and contains solutions of numerous examples taken from university examination papers.

METEOROLOGY

Exploring the Atmosphere's First Mile; Proceedings of the Great Plains Turbulence Field Program, 1 August to 8 September, 1953, O'Neill, Nebraska. Vol. 1: Instrumentation and Data Evaluation; Vol. 2: Site Description and Data Tabulation. Edited by Heinz H. Lettau and Ben Davidson. Published on behalf of the Geo-

Now! The FIRST Complete

MATERIALS HANDLING HANDBOOK

84 AUTHORITIES Combine The Know-how of Engineering and Industry — METHODS, SYSTEMS, DATA, DESIGN, INSTALLATION, OPERATION, AND EQUIPMENT!

READY to help you cut costs in *every phase* of modern materials handling — here is the hard-won experience of American engineering and industry, organized in a single compact volume. Never before approached in scope or usefulness, this new Handbook explains the governing principles, the methods and systems, and recommended equipment for moving material at least cost — whether in raw, in-process, or finished form.

ADAPTABLE TO ANY INDUSTRIAL SITUATION. The Handbook answers *every basic question of work flow* within and outside the plant. With it you now have the means for (1) systematically analyzing your own materials handling operations, (2) planning for greater efficiency, (3) installing and operating improved systems, and (4) measuring results.

★ **Editor: HAROLD A. BOLZ, Associate Dean, College of Engineering, The Ohio State University;**
★ **Associate Editor: GEORGE E. HAGEMANN, Consulting Engineer**

HOW-TO-DO-IT ILLUSTRATIONS. Hundreds of photographs, charts, drawings, cost and work-flow forms support the clear-cut recommendations for choosing equipment, timing and coordinating job movements, factory layout, production control, stockpiling, delivery of finished products, etc. Text and illustrations reflect the entire literature of materials handling to date — condensed, arranged for instant reference.

47 Sections! Factory Planning; Material Positioning Mechanisms; Research; Communication Systems; Training Personnel; Handling Bulk Materials; Unit Handling; Scrap Classification and Handling; Containers; Palletization; Warehousing; Truck, Railroad, Marine, Air Terminal Handling; Conveyors; Cranes, Derricks, Cableways; Elevators; Winches; Trucks; Tractors; Etc.

84 Contributing, Consulting Editors 6x9 1750 pp. 960 ills. $20

Sponsored by THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS and the AMERICAN MATERIAL HANDLING SOCIETY

CLIP AND MAIL COUPON NOW!

THE RONALD PRESS COMPANY
15 East 26th St., New York 10

Please rush _____ copies of the new, all-inclusive **MATERIALS HANDLING HANDBOOK.** Price $20 per copy.

☐ Check Enclosed ☐ Bill Me ☐ Bill Firm
(We pay postage when check accompanies order)

Name _____ AE-1
Firm _____
Address _____
City _____ Zone ____ State _____

physics Research Directorate, Air Force Cambridge Research Center, ARDC. London, New York, Pergamon Press, 1957. Vol. 1: 376 pp.; Vol. 2: 201 pp.; illus., diagrs., tables. $20 the set.

These two volumes contain the accounts of a series of elaborate meteorological experiments performed in open prairie country in Nebraska with the primary objective of studying the profiles of wind, temperature, and other meteorological quantities in the lower 2,000 *m* (atmospheric boundary layer); the turbulence structure, boundary fluxes of energy, momentum, and moisture; and the physical soil properties affected by diurnal variations of meteorological elements. Volume 1 deals with synoptic material, soil physiques, interface measurements, mast profile data, fluctuation quantities, free air observations, data evaluations concerning the heat budget constituents of the earth-air interface, classification of runs according to convective stability, and nondimensional analysis of atmospheric boundary-layer structure. Volume 2 describes the site, the climatology of the region, the scheduling of observations, and gives detailed tabulations of experimental data which are organized according to the observation periods.

Artificial Stimulation of Rain; Proceedings of the First Conference on the Physics of Cloud and Precipitation Particles, Held at Woods Hole Oceanographic Institution, Woods Hole, Mass., Sept. 7–10, 1955. Edited by Helmut Weickmann and Waldo Smith. Sponsored by the Geophysics Research Directorate, AFCRC, ARDC, and the Geophysics Branch, ONR. London, New York, Pergamon Press, 1957. 427 pp., illus., diagrs., tables. $15.

The forty-nine papers contained in these proceedings present the latest ideas, developments, and information on the many aspects of research allied to cloud physics, with special emphasis upon artificial precipitation. Various aspects of the subject are discussed under the following topic groupings: (1) Aerosols: their origin, distribution and measurement; (2) Condensation and coagulation; measurement of cloud- and rain-drop size; rain from water clouds; (3) Melting and freezing; studies of snow and ice in the generation of precipitation; (4) Crystal growth and nucleation, laboratory and field studies; (5) Thunderstorm electricity; and (6) International terminology.

Dynamical and Physical Meteorology. George J. Haltiner and Frank L. Martin. New York, McGraw-Hill Book Company, Inc., 1957. 470 pp., diagrs., tables. $10.

Intended primarily for those majoring in meteorology, this textbook is essentially a self-contained tool for the study of larger-scale atmospheric motions in which only those phases of physical meteorology that are closely linked with dynamic meteorology have been considered. Most topics are developed from basic principles to a point near their present stage, but the scope of the text is somewhat restricted due to the fact that little mathematics beyond differential and integral calculus is assumed. Both authors are Professors, U.S. Naval Postgraduate School, Monterey, Calif.

NUCLEAR ENERGY

Safety Aspects of Nuclear Reactors. Edited by C. Rogers McCullough. (The Geneva Series on the Peaceful Uses of Atomic Energy.) Princeton, N.J., D. Van Nostrand Company, Inc., 1957. 237 pp., illus., diagrs., tables. $8.50.

This book contains an edited collection of papers presented at Geneva in 1955 relating to the safety problem involved when handling radioactive materials. *Part I* of the study discusses normal hazards, monitoring and decontaminating reactor components, and studies of the dispersion of radioactivity by directing radiation, by liquids, by air currents and winds. *Part II* deals with the permissible concentration of radioactive material and the effects of radiation, the permissible doses compatible with the safety of the individual, I.C.R.P. standards, radioisotopes, and safety codes. Because of the lack of experimental data, genetic effects are not considered. *Part III* covers reactor accidents and consequences, safety design, radiation dispersion and monitoring, and an analysis of risks involved in a potential disaster. The editor is Chairman, Advisory Committee on Reactor Safeguards, AEC.

Atomic Energy Facts; a Summary of Atomic Activities of Interest to Industry. U.S. Atomic Energy Commission. Washington, Superintendent of Documents, 1957. 216 pp., illus., diagrs., tables. $2.00.

This volume combines and organizes material from many Commission sources on the peaceful uses of atomic energy. It presents also in eight appendixes the following information: basic principles of the controlled thermonuclear program, categories of restricted data available to access permit holders, depository libraries of U.S. Atomic Energy Commission, a bibliography of atomic energy rules and regulations, power reactor data tables, data for representative research reactors, gamma irradiation facilities, and a catalog of materials standards.

ANNOUNCING . . . . . .

THE PHYSICS OF FLUIDS

A new journal devoted to original contributions to the physics of fluids covering kinetic theory, statistical mechanics, structure and general physics of gases, liquids, and other fluids and including:

- Magneto-Fluid Dynamics
- Ionized Fluid and Plasma Physics
- Shock and Detonation Wave Phenomena
- Dynamics of Compressible Fluids
- Boundary Layer and Turbulence Phenomena
- Liquid State Physics and Superfluidity
- Hypersonic Physics
- Rarefied Gas Phenomena
- Upper Atmosphere Phenomena
- Physical Aeronomy
- Transport Phenomena
- Hydrodynamics

As well as certain basic aspects of physics of fluids bordering geophysics, astrophysics, biophysics and other fields of science. Published by the American Institute of Physics and edited by a distinguished board of scientists, the publication will be indispensable to all research workers, libraries, laboratories, and institutions interested in the broad field of the physics of fluids.

Editor, F. N. Frenkiel, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

Issued bimonthly—first issue, January, 1958

Subscription Rates: $10.00 domestic, $11.00 foreign

Orders and Inquiries should be addressed to:

AMERICAN INSTITUTE OF PHYSICS
335 East 45 Street **New York 17, N. Y.**

BUFFALO AND ERIE COUNTY PUBLIC LIBRARY DEPARTMENT OF TECHNOLOGY

PHYSICS

Experimental Crystal Physics. W. A. Wooster. Oxford, Eng., At The Clarendon Press; New York, Oxford University Press, 1957. 115 pp., diagrs., tables. $2.90.

The experiments described here are concerned with the optical, thermal, diamagnetic, paramagnetic, pyroelectric, piezoelectric, elastic, and plastic properties of crystals and are based on the course developed during the last thirty years in the Department of Mineralogy and Petrology, Cambridge University. Stressing the fundamental practical aspects of the subject, the author has included only those experiments which the student may complete in 2 or 3 hours.

PRODUCTION

Radiography in Modern Industry. 2nd Ed. Rochester, N.Y., X-Ray Division, Eastman Kodak Co., 1957. 136 pp., illus., diagrs., tables. $5.00.

Of particular interest to those responsible for industrial radiographic inspection, the revised edition contains information on the sensitometric characteristics of Kodak films, new data on radioactive isotopes and their application, and a guide for the selection of appropriate Kodak films for both X-ray and gamma-ray radiography. There is also new material on image amplification, geometric enlargement, and radiation monitoring.

Handbook of Layout and Dimensioning for Production. Hyman H. Katz. New York, The Macmillan Company, 1957. 479 pp., diagrs., tables. $15.

The aim of this book is to provide the "apprentice" draftsman with a working knowledge not furnished by the conventional academic approach to engineering drawing and to prepare him for further design responsibility. It stresses practical, industry-defined layout and dimensioning requirements. Each step in product development, from technical sketch to final drawing, is illustrated and detailed in terms of the procedures, principles, and theory involved and is related to the ultimate goal: optimally efficient mass production.

SPACE TRAVEL

Astronautics Symposium, Summary Session; Held at San Diego, Calif., February 18–20, 1957, Under the Sponsorship of the US AFOSR and Convair Division, General Dynamics Corp. San Diego, Calif., Convair Division, General Dynamics Corp., 1957. 55 pp.

This report represents a transcript of the Summary Session of the symposium which attempted to survey the present status of space flight research, to outline the problems remaining to be solved, and to indicate the most likely direction of future research.

Contents: Re-Entry, William H. Dorrance. Tracking and Communications, Clark A. Potter. Environment and Measurements, Fred L. Whipple. Propulsion, William Bollay. Orbits, Paul Herget. Human Factors, Hubertus Strughold.

THERMODYNAMICS

The Spectroscopy of Flames. A. G. Gaydon. New York, John Wiley & Sons, Inc., 1957. 279 pp., illus., diagrs., tables. $9.00.

This monograph discusses the nature and structure of flames supported by air or oxygen, by various halogens, and by oxides of nitrogen, and includes a chapter on flame spectrophotometry which deals with applications of our knowledge of excitation processes and equilibrium conditions in flame gases to the use of spectra excited in flames for purposes of chemical analysis. The material of the book is based largely on the author's experimental work at the Imperial College, London, and replaces his previous text, the 1948 edition of *Spectroscopy and Combustion Theory*, which summarized direct observations on the visible and ultra-violet emission spectra of flames and covered the infra-red region and absorption spectroscopy.

WEAPONS SYSTEMS

Proceedings of the National Midwestern Meeting Weapons System Management (Unclassified Portions), Dallas, Texas, November 7–8, 1957. Sponsored by the Institute of the Aeronautical Sciences in cooperation with the Texas Section of the IAS. New York, IAS, 1957. 57 pp., diagrs. $2.50 (IAS Members: $1.50).

Contents: Effective Management and National Security, S. E. Anderson. Concept of Weapon System Management, O. R. Cook. Purchasing for the B-58 Weapon System, Robert Kahn. The Role of Operation Research, Howard F. Marx. Subsystem Design Evaluation, J. E. Goode. Aero-Thermodynamic Factors in Modern Weapon System Management, William H. Dorrance. Management of the Army Guided Missile Program, Martin Schilling and Stanley Bernstein. Reduced Cooling Requirements Through Integrated Design, P. E. Petty. The Management Problem in Achieving Reliability in Missile Electronics, F. W. Lehan. Application of Weapon System Management Principles, William F. Ballhaus.

✦ ✦ ✦

IAS News *(Continued from page 69)*

The University of Wyoming

Two films, *Flight to the Future* and *Aeronautical Oddities*, were shown at the November 5 meeting.

L. Lloyd Jones, NACA Ames Aeronautical Laboratory, discussed the Laboratory's supersonic free-flight wind tunnel division at the October 28 meeting. Using slides, he discussed principles and techniques of free-flight testing.

Highlight of his talk was a demonstration on a portable model test range. A shadowgraph picture of a .22-cal. bullet, fired down the range, was developed immediately and passed among the audience.

ROBERT J. MILLER, *Secretary*

U.S. Naval Postgraduate School

Branch members and guests met on November 21 to hear "Capabilities and Performance of Present-Day Douglas Aircraft" presented by E. R. Heald, Assistant Chief for Aerodynamics, El Segundo Division, and Thomas G. Kilgariff, Test Pilot, both with Douglas Aircraft Company.

Mr. Heald reviewed the design problems and their related solutions associated with the "flying qualities of manned aircraft" which were encountered in the past decade. Among those discussed were inertia coupling and spinning, directional instability at high Mach Numbers and angles of attack, PIO (pilot induced oscillations) and control sensitivity, and unsatisfactory pitch and yaw damping.

Mr. Kilgariff summarized the problems associated with flight testing high-performance aircraft. He emphasized the results obtained through telemetering systems of the fully instrumented test vehicle.

EDWIN L. EBBERT
Corresponding Secretary

✦ ✦ ✦

Keep Posted on New Aircraft & Missile Products and Product Literature

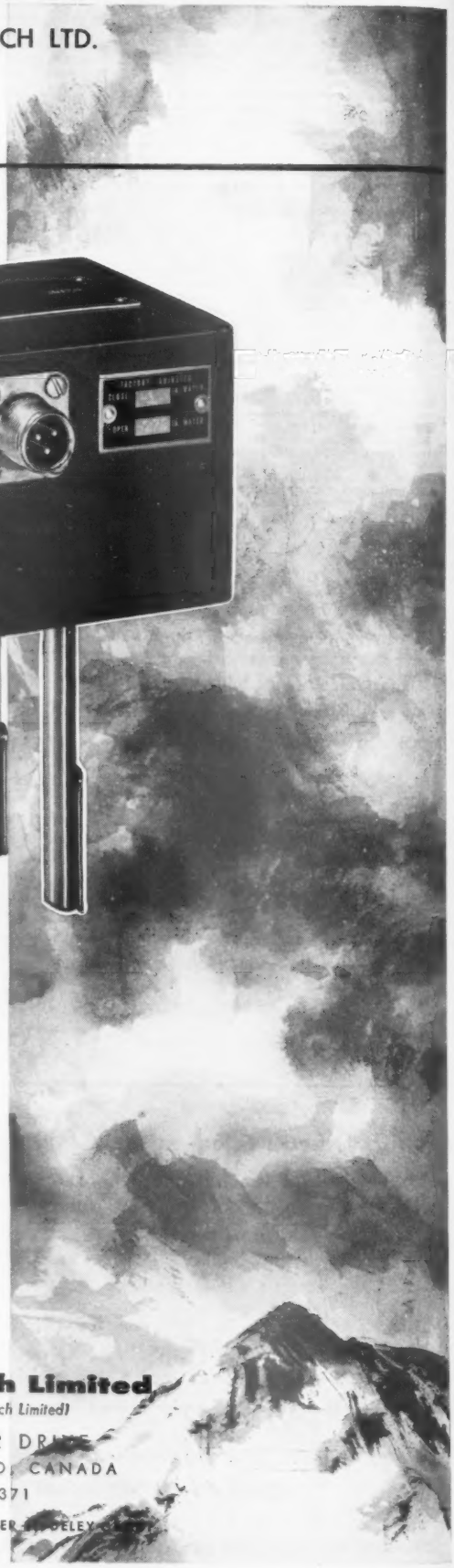
Make it a habit to check the *Aeronautical Engineering Review's* "New Products Section" every month. Located at the end of each issue, it contains a complete review of all recently announced new product developments and product literature of special interest to the aeronautical profession. Handy tear-out postals are included for your convenience in requesting additional information direct from the manufacturers.

Make It a Habit—Use the "New Products Section" Every Month

AERONAUTICAL ENGINEERING REVIEW

XUM

ANOTHER FIRST BY CANADIAN APPLIED RESEARCH LTD.



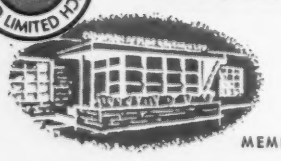
The World's most efficient Ice Detection System . . .

You are looking at the most efficient ice detection system yet developed—the Type T260 dual probe detector. Here is a 1¾-pound, sealed package unit that either warns the pilot of icing conditions long before he can see ice forming, or automatically controls his ice shedding system—depending on the application of the 28 volt output pulse.

Engineered and manufactured by Canadian Applied Research Limited, under license from the National Research Council of Canada, the detection and reference probes and associated pressure switch are contained in a sealed unit, eliminating inter-connecting pneumatic tubing and reducing electrical cable requirements. Operationally proven by the RCAF and now standard equipment on the Avro CF-100 and its Orenda jet engines, the ice detection system is now available to private and commercial aircraft operators. Write us for literature and quotations.

Specifications:

Size — 3⅛" x 3⅛" x 5²¹⁄₃₂"
Probes — 3" long, 5⁄16" diameter
Weight — 1¾ pounds
Power — 28 volts, 15 amps. Intermittent



Canadian Applied Research Limited
(formerly PSC Applied Research Limited)
1500 O'CONNOR DRIVE
TORONTO 16, ONTARIO, CANADA
PLYMOUTH 5-3371
MEMBER: A. V. ROE CANADA LIMITED & HAWKER SIDDELEY

XUM

Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and eligible organizations offering employment to Aeronautical specialists. Any member or eligible organization may have requirements listed without charge by writing to the Secretary of the Institute.

Wanted

Assistant or Associate Professor—to teach undergraduate courses in aeronautical engineering and graduate courses in propulsion, instrumentation, or structures. Industrial and teaching experience desired. Opportunities available for further graduate study, consulting, and research. Send résumé of education and experience to: Chairman, Department of Aeronautical Engineering, Wayne State University, Detroit 2, Michigan.

Electrical Engineers—interested in an academic position combining teaching and fundamental experimental research. Assistant professorship available for a recent Ph.D. or equivalent background, higher rank in accordance with qualifications. Write to D. C. Drucker, Chairman, Division of Engineering, Brown University, Providence 12, R.I.

Assistant Professors—to teach undergraduate and graduate courses in engineering mechanics with opportunities to conduct research. This is an excellent opportunity to join an active and growing department. Also, graduates of civil, mechanical, and aeronautical engineering for *full-time and part-time teaching and research* positions. Opportunity also to study for M.S. and Ph.D. degrees on a part-time basis. Department has currently about 30 graduate students working for M.S. and Ph.D. degrees. Applications should be addressed to Prof. Joseph Marin, Head, Department of Engineering Mechanics, The Pennsylvania State University, University Park, Pa.

Section Chief, Structural Research, Research Division—An unusual opportunity is available for a properly qualified engineer to combine activity in the most advanced aircraft structural research and development studies with supervisory and management responsibilities. He is to lead, supervise, and coordinate the activities of the Internal Research Group, pursuing State-of-the-Art studies; Contractual Research Group, handling Government research contracts; and the Heat-Transfer Group, studying and interpreting aerodynamic heating problems. The Section consists of 15 engineers, most of them with advanced degrees. The position also entails teaching applicable courses and lecturing on special topics within the company. It is believed that a university professor, in the applicable field, would find this an interesting and challenging opportunity. Requirements are Ph.D. or M.S. with a minimum of 8 years of directly applicable experience. Salary is to be commensurate with qualification. **Section Chief, Aerodynamics, Aircraft Division**—Responsibilities include directing efforts of Section engineers in all aerodynamic studies, including flow, flutter, aeroelasticity, stability, wind-tunnel models, and tests on projects currently involving VTOL aircraft. Advanced degree in Aero. Engineering with at least 8 years' related experience including supervision of a sizable group of aerodynamicists. Salary commensurate with qualifications. **Project Flight Control Systems Engineer, Aircraft Division**—Responsible for all major decisions pertaining to automatic flight control systems. Advanced degree in engineering with 7 or 8 years' progressive experience in autopilots, servomechanisms, hydraulic powered flight controls, dynamic stability, and flight and laboratory testing. Salary commensurate with ability. Send inquiries to George E. Klock, Engineering Employment Supervisor, Industrial Relations Department, Bell Aircraft Corporation, P.O. Box One, Buffalo 5, N. Y.

Available

844. Aerodynamics Engineers and Specialists—Three engineers with broad experience in gas dynamics, propulsion, and the aerodynamics of subsonic, transonic, supersonic, and hypersonic flight desire research and development assignments relating to the performance, air loads, and stability and control of aircraft and missiles. Combined experience includes many years in basic aeronautical research in addition to work in the preliminary design and development of aircraft and missiles presently in production. Currently holding responsible positions in the aeronautical engineering division of a large airframe manufacturer, but desire assignments on a part-time basis. Los Angeles area preferred.

843. Engineer—B.S. degree, prominent engineering college. Twenty years' experience all in airframe design, some of which was in rotary-wing aircraft. Has held responsible positions with titles of design engineer, etc., with various East and West Coast aircraft manufacturers. Presently employed on East Coast but feels need to change for monetary reasons. Desires employment in eastern or midwestern United States with company that can make use of his aircraft experience. Would be willing to go into missile field with proper inducement. Present employer knows of this advertisement. Résumé on request.

842. Executive Engineer—seeks challenging position in consulting engineering, small manufacturing plant, or development organization, in Northeast Coast area or Europe. Ten years' experience in aircraft power-plant development (including reciprocating, turbojet, and liquid propellant rocket) and sales of engineering services. B.Ae.E., M.M.E., P.E. (New York and New Jersey), and D.Sc.E. candidate (Industrial & Management Engrg.). Fluent German.

841. Executive Coordinator-Counsel—A.B., LL.B.; 14 years in aeronautical research and development agencies; responsible for legal, legislative, and liaison functions, policy formulation, internal and external coordination; Counsel for U. S. Senate committee on export control and policies; and private law practice. Qualified as counsel or as assistant to top executive, especially in fields of Government relations, administrative planning, trouble shooting, and public relations.

840. Management—17 years of diversified experience in propulsion, missiles, and electronics—e.g., long-range planning, product planning and market research, engineering organization, budgets and controls, sales, project engineering, research. Mechanical engineering degree plus graduate business school. Interesting work and growth potential are of paramount importance. Résumé upon request.

839. Advertising and Public Relations Manager—B.S. Engineering Management, M.B.A Industrial Marketing, Ph.D. candidate Advertising. Age 37. Twelve years' intensive experience in industrial marketing techniques: program planning, budgeting, and administration; market and media analysis; agency liaison; and technical advertising, sales promotion, and publicity copy. Government, industry, community, and press relations. Licensed pilot, mechanic, and radioman with marketing background in aviation equipment, air transport, avionics, automation, and nucleonics. Desires broader responsibilities leading to marketing management.

838. Engineer-Executive—Age 37. B.Ae., 1942. Eleven years' experience in the field of vertical flight. Business experience includes military contract negotiation, cost and time estimating, financing negotiations, and general problems associated with small businesses. Engineering experience includes proposal writing, preliminary design studies of complete rotorcraft, aerodynamics and performance analysis, structural analysis, mechanical vibration analysis, statistical analysis, static and dynamic testing, operation and maintenance studies, application of various power plants to helicopters. Project and chief engineer level. Experience covers helicopters, VTOL aircraft, and shrouded rotor systems. Desires responsible position in rotary-wing field or will consider adaptation to the fields of rocket propulsion or astronautics.

PUBLICATIONS AND SERVICES available to IAS members

Engineering Research Libraries. Located in New York City and Los Angeles, IAS Libraries give you direct access to one of the most comprehensive stores of aeronautical knowledge in the world. Reports, periodicals, and books are made available through its lending, photocopy, and reference facilities.

"Aeronautical Engineering Catalog." This annual directory to the manufacturers of aircraft and missile products is available to IAS Members without charge on request. Contains over 35,000 manufacturers listings, product specifications and data, and company names and addresses.

Personnel Opportunities. This contact service publicizes your availability for employment throughout all branches of the industry. Members may be listed without charge. Also keeps you posted on openings in the industry.

IAS Roster of Members. This directory of the aeronautical engineering profession appears each year in the September issue of the AERONAUTICAL ENGINEERING REVIEW. Enables you to locate your professional associates.

For information on these and other IAS services, write to:

INSTITUTE OF THE AERONAUTICAL SCIENCES • 2 E. 64th St., New York 21, N.Y.

XUM

IAS Preprints

Preprints of 26th Annual Meeting Papers Currently Available

		Member Price	Nonmember Price
764	Incompressible Two-Dimensional Stagnation-Point Flow of an Electrically Conducting Viscous Fluid in the Presence of a Magnetic Field—J. L. Neuringer and W. McIlroy.	$0.35	$0.75
765	A Simple Method of Matric Structural Analysis—Part III. Flexible Frame and Stiffened Cylindrical Shell Analysis—Bertram Klein.	0.35	0.75
766	On Vibrations of Conical Shells—G. Herrmann and I. Mirsky.	0.50	0.85
767	An Optimum Design for a Semi-Infinite Rocket Wall Containing a Circumferential Keyway—B. W. Shaffer, I. Cochin, and M. Mantus.	0.50	0.85
768	Supersonic Airfoil Performance with Small Heat Addition—Artur Mager.	0.50	0.85
769	Vibrations of Thin Cylindrical Shells Analyzed by Means of Donnell-Type Equations—Yi-Yuan Yu.	0.65	1.00
770	Autorotation of Fuselages—Mark H. Clarkson.	0.35	0.75
771	Statics and Dynamics of Non-Uniform Curved Beams and Prismatic Shells—F. F. Ehrich and J. P. de Vries.	0.50	0.85
772	Transport Airplane Crash Loads—G. M. Preston and G. J. Pesman.	0.50	0.85
773	The Minimum Weight of a Structure Protected Against Short Duration Aerodynamic Heating by Means of Thermal Insulation—Richard A. Dobbins.	0.50	0.85
774	The Hecker Method of Transient Temperature Calculation—A. W. Trimpi.	0.50	0.85
775	Approximate Three-Dimensional Solutions for Transient Temperature Distribution in Shells of Revolution—M. A. Brull and J. R. Vinson.	0.50	0.85
776	Theoretical Considerations of Flutter at High Mach Numbers—H. G. Morgan, H. L. Runyan, and Vera Huckel.	0.50	0.85
777	Thermal Stresses and Deflections in Rectangular Sandwich Plates—P. O. Bijlaard.	0.50	0.85
778	Some Effects of Curvature on Frames—R. W. Westrup and P. Silver.	0.50	0.85
779	Creep and Static Strengths of Large Bolted Joints of Forged Aluminum Alloys under Various Temperature Conditions—L. Mordfin, G. E. Greene, N. Halsey, R. H. Harwell, Jr., and R. L. Bloss.	0.65	1.00
780	Aircraft Fatigue—Is Low Strength Material the Answer?—C. R. Smith.	0.35	0.75
781	Hydro Fatigue Test of the C-130A Hercules—J. E. York.	0.35	0.75
782	On Optimum Thin Lifting Surfaces at Supersonic Speeds—H. Yoshihara, J. Kainer, and T. Strand.	0.50	0.85
783	A Semi-Empirical Analytical Method of Obtaining Aerodynamic Derivatives—N. H. Van Dorn.	0.35	0.75
784	A Comparison of Theoretical and Experimental Loads on The B-47 Resulting from Discrete Vertical Gusts—C. E. Jackson and J. E. Wherry.	0.65	1.00
785	Some Structural Response Characteristics of a Large Flexible Swept-Wing Airplane in Rough Air—T. L. Coleman, H. N. Murrow, and H. Press.	0.50	0.85
786	A Rational Determination of Loads and Exit Velocities of Cartridge Ejected Stores—H. Wolf and S. Pines.	0.35	0.75
787	Some Applications of Theoretical Aerodynamics to the Design of High Performance Aircraft—G. C. Grogan, Jr.	0.35	0.75
788	Aeroballistics Range Measurements of the Performance and Stability of Supersonic Aircraft—H. R. Warren, R. J. Templin, and B. Cheers.	0.50	0.85
789	The Minimum Wave-Drag Problem for the Addition of a Body to a Given Airplane Configuration—J. F. Vandrey.	0.50	0.85
790	Air Traffic Demand of the Decade: 1953–1963—A. D. Harvey.	0.35	0.75
791	The Jet-Flapped Wing in Two- and Three-Dimensional Flow—W. F. Jacobs and J. H. Paterson.	0.65	1.00
792	The Transonic Flow Field of an Axial Compressor Blade Row—J. E. McCune.	0.50	0.85
793	A Linear Perturbation Method for Stability and Flutter Calculations on Hypersonic Bodies—Maurice Holt.	0.35	0.75
794	The Satellite Tracking Camera—Joseph Nunn.	0.35	0.75
795	The Air Force Instrument Development Program—Brig. Gen. Marvin C. Demler.	0.75	1.25
796	The Environment of Space in Human Flight—Major C. A. Berry.	0.35	0.75
797	Supersonic and Hypersonic Human Flight—Capt. J. E. Ward, Dr. S. J. Gerathewohl, and Lt. Col. G. R. Steinkamp.	0.35	0.75
798	Cybernetics in Human Flight—G. T. Hauty.	$0.35	$0.75
799	The Development of the Air Route Structure and Separation Standards—Lee E. Warren.	0.35	0.75
800	The Role of Radar in Air Traffic Control 1953–1963—J. H. Hilton.	0.35	0.75
801	The Supersonic Blunt-Body Problem—Review and Extension—M. D. Van Dyke.	0.50	0.85
802	Chemical Relaxation in Air, Oxygen and Nitrogen—M. Camac, J. Camm, S. Feldman, J. Keck, and C. Petty.	0.50	0.85
803	Intelligence Sources for Guidance—Arthur S. Locke.	0.35	0.75
804	The Development of the Talos Land-Based System—D. B. Holmes.	0.35	0.75
805	Pitch-Lag Instability of Helicopter Rotors—Pei Chi Chou.	0.50	0.85
806	Direct Analog Method of Analysis of the Vertical Flight Dynamic Characteristics of the Lifting Rotor with Floating Hub—R. H. MacNeal.	0.65	1.00
807	Pitch-Lag Instability as Encountered During Tests of a Model Rotor—John W. McKee.	0.35	0.75
808	Research in the Field of Wingless VTOL Aircraft—A. M. Lippisch.	0.35	0.75
809	Naval Applications of VTOL-STOL Vehicles—H. G. Sheridan.	0.35	0.75
810	Solutions for Helicopter Rotor Blade Icing—D. A. Richardson, H. A. Wahl, and J. M. Clifford.	0.50	0.85
811	An Analytical Procedure for the Preliminary Structural and Dynamic Design, and Weight Estimation of Helicopter Rotor Blades—Abner Rasumoff.	0.50	0.85
812	On the Hydrodynamic Stability of Curved Laminar Compressible Flows—M. Lessen.	0.50	0.85
813	Long-Range Planning (A Symposium)—W. B. O'Neal, G. C. Covington, R. L. Bottner and W. Purdy.	0.35	0.75
814	NACA Research in the Field of VTOL and STOL Aircraft—C. H. Zimmerman.	0.50	0.85
815	The Army-Navy Instrumentation Program—Commander George W. Hoover.	0.35	0.75
816	On Reducing Aerodynamic Heat Transfer Rates by Magnetohydrodynamic Techniques—R. C. Meyer.	0.50	0.85
817	Examples of Detached Bow Shock Waves in Hypersonic Flow—P. R. Garabedian and H. M. Lieberstein.	0.65	1.00
818	The Dynamics and Certain Aspects of Control of a Body Re-entering the Atmosphere at High Speed—Joseph D. Welch and S. L. Shih.	0.50	0.85
819	Interrelations of Space Medicine with Other Fields of Science—Hubertus Strughold.	0.35	0.75
820	Analysis of the Vertical Flight Dynamic Characteristics of the Lifting Rotor with Floating Hub and Off-Set Coning Hinges—K. H. Hohenemser and C. H. Perisho.	0.50	0.85
821	Development, Flight Test, and Evaluation of a Mechanical Stabilizer for Single Rotor Helicopters—G. E. Dausman, D. F. Gebhard, and L. Goland.	0.35	0.75
822	Effects of a Time-Varying Test Environment on the Evaluation of Dynamic Stability with Application to Flutter Testing—W. H. Reed III.	0.50	0.85
823	The Plastic Balloon as a Geophysical Platform—R. H. Braun.	0.35	0.75
824	Project Far Side Launching—John L. Cramer.	0.50	0.85
825	Industry and Education (Combining 3 of the 4 papers presented at session)—Charles S. Draper, Richard G. Bowman and Glenn Murphy.	0.50	0.85
826	Supersonic Civil Air Transports With Consideration of Potential VTOL Capabilities—James A. O'Malley, Jr.	0.50	0.85
827	Preliminary Investigation of a Ducted Fan in Lifting Forward Flight—Norman D. Ham and Herbert H. Moser.	0.50	0.85
828	Booster Propulsion For Space Vehicles—R. S. Wentink.	0.50	0.85
829	The Regulatory Problems of Jet Aircraft—Oscar Bakke.	0.35	0.75
830	Cosmology—Winston H. Bostick.	0.35	0.75
831	The Arctic Distant Warning System—W. E. Burke.	0.65	1.00
832	The Flying Platform as a Research Vehicle for Ducted Propellers—Alvin H. Sacks.	0.50	0.85
833	The 3 Manned Stratosphere Balloon Ascents of 1957—Otto C. Winzen.	0.75	1.25
834	The Role of Manned Balloons in The Exploration of Space—Malcolm D. Ross and M. Lee Lewis.	0.65	1.00

Order by number from: Preprint Dept., IAS, 2 E. 64th St., New York 21, N.Y.